



# **Wenatchee River Basin Total Maximum Daily Load for Dissolved Oxygen, pH, and Fecal Coliform**

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**Partial Completion of the Final Technical Report  
After the First Year of Data Collection**

April 2004 – DRAFT Interim Report

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*by*  
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Olympia, Washington 98504-7710

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# Abstract

As part of the Wenatchee River total maximum daily load (TMDL) study, the Washington State Department of Ecology (Ecology) conducted a series of water quality surveys in 2002-2003. This report summarizes the data QA/QC and reports preliminary findings.

Despite high variability in the Year 2 data, the QA and QC review suggests that the Year 1 and 2 data are of good quality and are properly qualified.

Natural dissolved oxygen (DO) concentrations in Class AA reaches will likely be less than 9.5 mg/L during the summer months due to high water temperature. Implementation of the Wenatchee River temperature TMDLs will improve DO as much as possible. BOD and nutrient loading should also be restricted to keep from further reducing DO.

Data showed DO and pH exceedances in lower Icicle Creek and Wenatchee River caused by periphyton productivity. Particularly, a deleterious low-DO condition exists at the mouth of the Wenatchee River. The mouth of the Wenatchee River appears to be the most water-quality limited segment in the Wenatchee basin. Phosphorus appears to be the nutrient to control periphyton biomass in the lower Wenatchee River.

The FC criterion was exceeded throughout the Mission, Brender, and Chumstick creek watersheds except at or near the Forest Service headwater boundaries. Simple mass-balance load analyses of the each creek identified specific reaches with the highest FC loading to the creeks.

Data will be used to build and calibrate a QUAL2K model of the Wenatchee River and lower Icicle Creek. Ecology will use the model to recommend TMDL pollutant limitations to protect the water quality of the Wenatchee River and Icicle Creek. In addition, FC data assessed in this report will be used to develop bacteria mass balances to identify tributary reaches with high bacteria loading and establish FC load allocations.

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# Introduction

## Background

In 1998, the Wenatchee River and Icicle, Chumstick, Mission, and Brender creeks were included on Washington's 303(d) list of impaired waters because of dissolved oxygen (DO), pH, and fecal coliform bacteria (FC) water quality standard violations. The 303(d) list (required by section 303(d) of the federal Clean Water Act) is a list of waterbodies that are not meeting water quality standards. Ecology is required by the Clean Water Act to conduct a Total Maximum Daily Load (TMDL) evaluation for waterbodies on the 303(d) list. The evaluation begins with a water quality technical study.

Consequently, in June 2002, Ecology began two years of monitoring as part of a water quality study of DO, pH, and FC in the Wenatchee River watershed. The first year of surveys focused on the mainstem Wenatchee River and Icicle Creek, while the second year was limited to Chumstick, Mission, and Brender creek watersheds. The second year of water quality surveying is complete as of spring 2004; this report pertains only to data collected prior to 2004. The study area includes the entire Wenatchee River watershed (Figure 1).

This interim report presents summaries of data collected during these surveys, including laboratory and field water quality data and flow data from instantaneous flow measurements. A summary of the quality assurance and quality control analysis of the data is also provided. Ecology will use the data to develop and calibrate a hydrodynamic and water quality computer model of the Wenatchee River, and Icicle, Chumstick, Mission, and Brender creeks.

## Study Area

The Wenatchee River Subbasin (WRIA 45) encompasses 878,423 acres and is located in the central part of Washington State. The subbasin is bounded on the west by the Cascade Mountains, on the north and east by the Entiat Mountains, and on the south by the Wenatchee Mountains. The Wenatchee is a subbasin to the Columbia River and enters that system at the city of Wenatchee 15 miles upstream of the Rock Island Dam. The geology of the upper subbasin consists of high and low relief landtypes associated with glaciation (e.g. cirque headwalls, glaciated ridges, and glacial/fluvial outwash). The middle part of the subbasin is a mixture of igneous and basalt rock formations and glacial/fluvial outwash terraces. Alluvial fans and terraces are predominant landtypes in the lower Wenatchee (Mainstem Wenatchee Watershed Assessment, 1999).

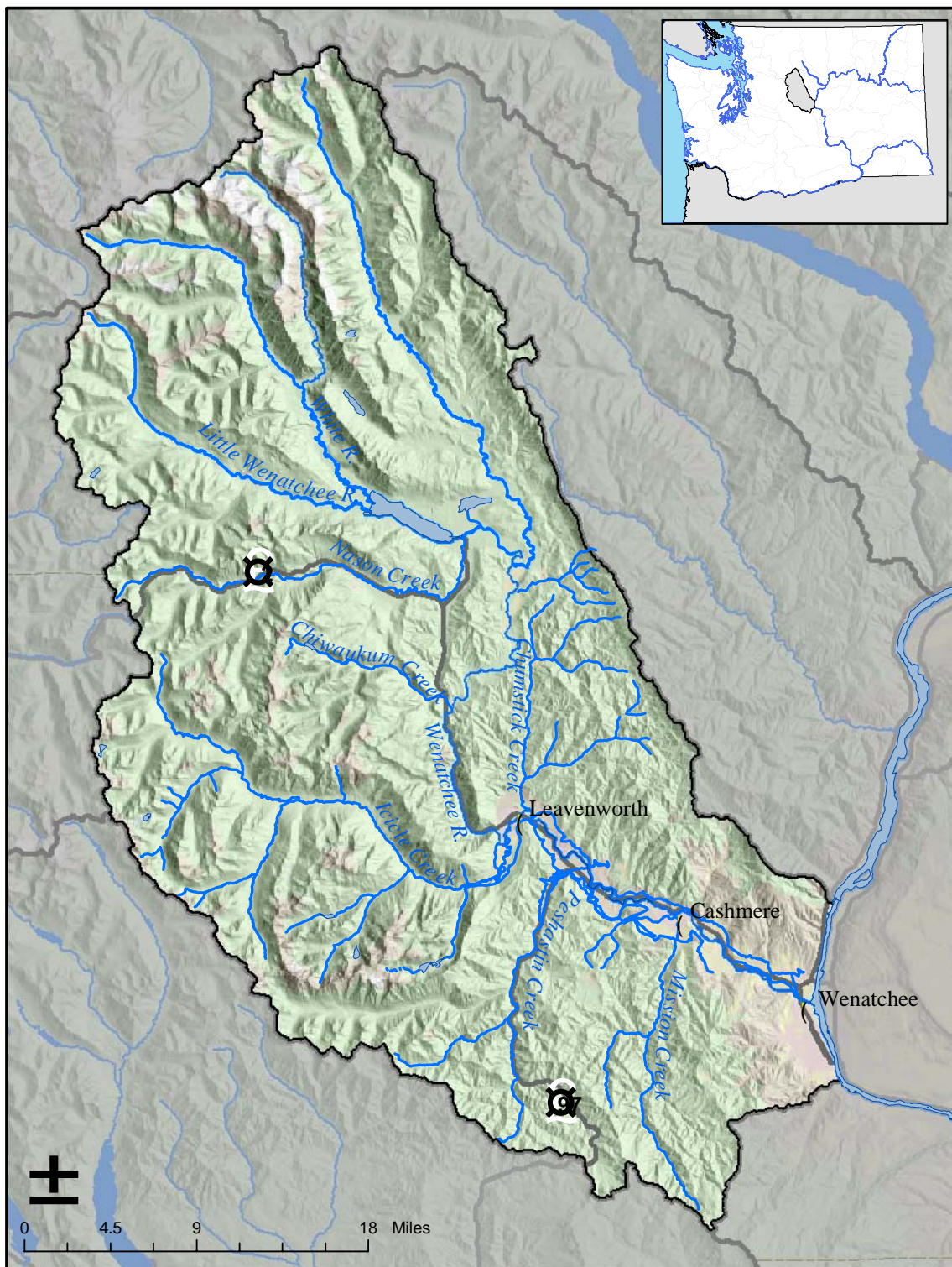


Figure 1. Study area for the Wenatchee River TMDL.

Annual average precipitation throughout the subbasin ranges from 150 inches at the crest of the Cascades to 8.5 inches in Wenatchee (Mainstem Wenatchee Watershed Assessment, 1999). Streamflow varies during the year, but mean monthly discharge peaks in spring from combined effects of snowmelt and rain-on-snow events. Most of the annual stream flow in the Wenatchee River originates from tributaries in the upper subbasin: the White River (25%), Icicle Creek (20%), Nason Creek (18%), the Chiwawa River (15%), and the Little Wenatchee River (15%) (Andonaegui, 2001). Both the White and the Little Wenatchee rivers enter Lake Wenatchee in the upper subbasin; the mouth of the lake is the head of the Wenatchee River and Nason Creek enters the river just below the lake outlet.

There is a mixture of federal, state, county, and private land ownership throughout the subbasin. Most of the upper subbasin is designated federal wilderness area and is under the jurisdiction of the U.S. Forest Service Lake Wenatchee and Leavenworth Ranger Districts. State Highways 2 and 97 parallel much of the Wenatchee mainstem and Nason Creek and contain portions of their streambanks. The incorporated cities designated in the 2000 census are Wenatchee (population 27,856), Cashmere (population 2,965), and Leavenworth (population 2,074). There are smaller unincorporated towns and communities located along State Highways 2 and 97 (2000 census information).

## **Classification and Water Quality Criteria**

The Washington State Water Quality Standards, set forth in Chapter 173-201A of the Washington Administrative Code, include designated beneficial uses, water body classifications, and numeric and narrative water quality criteria for surface waters of the state.

The Wenatchee River is a tributary to the Class A portion of the Columbia River (WAC 173-201A-030). Consequently, the Wenatchee River from its mouth to the Forest Service boundary is considered a Class A, “excellent,” water body. Similarly, Icicle, Chumstick, Mission, and Brender creeks all discharge to the Class A portion of the Wenatchee River. Those creeks and their tributaries are consequently considered Class A waterbodies from their respective confluences with the mainstem Wenatchee River to the Wenatchee National Forest boundary. From the Wenatchee National Forest boundary to their headwaters, Icicle, Chumstick, and Mission creeks are all considered Class AA, “extraordinary,” water bodies. Characteristic uses for Class A water bodies include water supply (domestic, industrial, agricultural), stock watering, fish and shellfish (salmonid and other fish migration, rearing, spawning, harvesting), wildlife habitat, recreation (primary contact recreation, sport fishing, boating, aesthetic enjoyment), and commerce and navigation. Characteristic uses for Class AA are considered identical to Class A characteristic uses.

Numeric criteria for specific water quality parameters are intended to protect designated uses. However, criteria are more stringent in AA waters such that the class shall markedly and uniformly exceed the requirements for all, or substantially all, uses. Current standards are listed below for each parameter of concern in the Wenatchee River watershed.



## DO

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- For Class A Waters: *dissolved oxygen shall exceed 8.0 mg/L.*
- For Class AA waters: *dissolved oxygen shall exceed 9.5 mg/L.*

## Fecal coliform bacteria

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- For Class A Waters: *“...fecal coliform organism levels shall both not exceed a geometric mean<sup>1</sup> value of 100 colonies/100mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.”*
- For Class AA Waters: *“...fecal coliform organism levels shall both not exceed a geometric mean value of 50 colonies/100 mL and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.”*

## pH

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- For Class A Waters: *pH shall be within the range of 6.5 to 8.5 with a human-caused variation within the above range of less than 0.5 units.*
- For Class AA Waters: *pH shall be within the range of 6.5 to 8.5 with a human-caused variation within the above range of less than 0.2 units.*

Natural conditions are addressed in the water quality standards as part of the antidegradation policy (WAC 173-201A-070) which states: *“Whenever the natural conditions of said waters are of lower quality than the criteria assigned, the natural conditions shall constitute the water quality criteria.”*

The water quality standards are currently under revision. Changes have been adopted and are awaiting EPA approval for DO, microbial pathogens (currently represented by the fecal coliform group), and temperature numerical standards. Fresh waters will be classified by use (such as fish habitat, swimming and water supply), rather than by class (AA, A, B, C and Lake classes), to allow the standards to be more tailored to specific water body uses. The proposed new standards would not represent any changes to the numeric criteria for DO, FC, and pH in the Wenatchee Basin. Proposed new standards can be found on the Ecology website: <http://www.ecy.wa.gov/programs/wq/swqs/index.html>.

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<sup>1</sup> The geometric mean is calculated as the n<sup>th</sup> root of the product of n numbers

## Project Objectives

The objectives of the study are to:

1. Conduct water quality monitoring surveys for physical, chemical, and biological parameters to determine sources affecting DO, pH, and bacteria levels in the Wenatchee River, and Icicle, Chumstick, Mission, and Brender creeks and their tributaries.
2. Assess or model productivity in streams using data from all parameters collected during the surveys.
3. Characterize FC concentrations and identify major bacterial loading sources along Mission, Brender, and Chumstick creeks.
4. Set DO, pH, and fecal coliform TMDL targets, nonpoint load allocations, and point source waste load allocations for parameters responsible for causing DO, pH, and fecal coliform exceedances in the Wenatchee River, and Icicle, Chumstick, Mission, and Brender creeks.

# Methods

## Study Design

Field personnel from Ecology and the Chelan County Conservation District collected water quality data during a series of surveys. Surveys were conducted on the following 24 dates:

Year 1 sample dates	Year 2 sample dates
June 4 – 6, 2002	July 7 – 9, 2003
June 25 – 26, 2002	July 21 – 23, 2003
July 8 – 9, 2002	August 4 – 6, 2003
July 22 – 24, 2002	August 18 – 20, 2003
August 5 – 6, 2002	August 25 – 27, 2003
August 26 – 28, 2002	September 8, 2003
September 9 – 10, 2002	September 22 – 24, 2003
September 23 – 25, 2002	September 29 – October 1, 2003
October 9, 2002	October 6 – 8, 2003
October 21 – 22, 2002	October 20 – 21, 2003
November 12 – 13, 2002	
December 2 – 3, 2002	
January 6 – 7, 2003	
April 7 – 9, 2003	

Sampling events for Year 1 (June 2002 through April 2003) covered 42 stations in the mainstem Wenatchee River drainage and 18 stations in the Icicle Creek drainage. The sampling stations were divided, and two teams of two samplers each sampled all 60 sites over the course of three days. Sampling events for Year 2 (July 2003 through October 2003) covered 22 stations in the Chumstick Creek drainage, 22 stations in the Mission Creek drainage, and 23 stations in the Brender Creek drainage. Sampling for Year 2 will continue in 2004. This report pertains only to data collected prior to 2004. Hydrolab® meters were used by each team to collect pH, conductivity, DO, and temperature measurements. Laboratory parameters for each site are described in the Quality Assurance Project Plans (Bilhimer et al., 2002, and Bilhimer et al., 2003) and methods are shown in Tables 1a and 1b.



Table 1a. Summary of field measurements and methods.

Parameter – Field Measurements	Method
Velocity	Marsh-McBirney current meter
Specific conductivity	Hydrolab meter
pH	Hydrolab meter
Temperature	Hydrolab meter
Dissolved oxygen	Hydrolab meter; Winkler modified azide (EPA 360.20)

Table 1b. Summary of laboratory measurements and methods.

Parameter	EPA Method
Alkalinity	SM2320
Biochemical Oxygen Demand (BOD)	405.1
Chloride	300.0
Chlorophyll a	SM 10200H(3) <sup>1</sup>
Dissolved Organic Carbon	415.1
Ammonia	SM4500NH3H
Nitrate/Nitrite	SM4500NO3I
Nitrogen – Total Persulfate	SM4500NB
Ortho-phosphate	SM4500PG
Phosphorus, total	365.3
Phosphorus, total low-level	200.8M
Total Suspended Solids	SM2540D
Total Nonvolatile Suspended Solids	160.4
Total Dissolved Solids	160.1
Total Organic Carbon	415.1
Turbidity	SM2130
Fecal Coliform	SM MF 9222D <sup>1</sup>

<sup>1</sup> SM indicates Standard Methods rather than EPA method.

In addition to the sampling events listed above, the following data-collection approaches were used to gather data to meet the objective of this study:

1. Field measurement surveys to collect continuous data from selected mainstem Wenatchee River and Icicle Creek sites.
2. Point source discharge water quality surveys conducted concurrently with intensive sampling events.
3. Groundwater surveys assessing relative surface water and groundwater head relationships, groundwater temperature, and water quality.
4. Travel time estimates in the mainstem Wenatchee River.

Ecology survey data will be used to calibrate a QUAL2Kw model that will be used to simulate the fate and transport of water quality, including DO and pH.

# Data Quality Objectives and Analytical Procedures

Target precision, bias, and accuracy as well as required reporting limits are listed in Table 2.

Table 2. Targets for accuracy, precision, bias, and reporting limits for the sample measurement.

<b>Analysis</b>	<b>Accuracy</b> % deviation from true value	<b>Precision</b> Relative Standard Deviation (%)	<b>Bias</b> % deviation from true value	<b>Required Reporting Limits</b> Concentration units
<b>Field Measurements</b>				
Velocity*	± 2% of reading; 0.1 f/s	N/A	N/A	0.05 f/s
pH*	0.20 s.u.	N/A	0.10 s.u.	N/A
Water Temperature*	± 0.2°C			N/A
Dissolved Oxygen	N/A	N/A	5	1 mg/L
Specific Conductivity	N/A	N/A	5	1 umhos/cm
<b>Laboratory Analyses</b>				
Alkalinity	25	<10	5	10 mg/L
Ammonia Nitrogen	25	<10	5	10 ug/L
Biochemical oxygen demand	N/A	<25	N/A	2 mg/L
Chloride	15	< 5	5	0.1 mg/L
Chlorophyll a	50	<20	10	0.05 ug/L
Dissolved Organic Carbon	30	<10	10	1 mg/L
Fecal Coliform (MF)	N/A	<25	N/A	1 cfu/100 mL
Nitrate-Nitrite Nitrogen	25	<10	5	10 ug/L
Ortho-phosphate P	25	<10	5	3 ug/L
Total Dissolved Solids	30	<10	10	1 mg/L
Total Nonvolatile Suspended Solids	N/A	<10	N/A	1 mg/L
Total Organic Carbon	30	<10	10	1 mg/L
Total Persulfate Nitrogen	30	<10	10	25 ug/L
Total Phosphorus	25	<10	5	3 ug/L
Total Suspended Solids	30	<10	10	1 mg/L
Turbidity	30	<10	10	1 NTU

\* as units of measurement, not percentages

## **Sample Collection and Field Measurement Methods**

The following is a description of sample collection and field measurement methods for data collected by Ecology. Figures 2 through 8 show all of the sampling site locations divided by watershed. Tables 3 through 9 list the sampling station identification (which includes the river mile), description, and latitude and longitude of the sampling sites, and the general type of data collected at each site. Information about the methods used to collect the historical or pre-existing data presented in this report (i.e., data not collected by Ecology) can be found in the associated source references or acquired directly from the reported source (e.g., information about the Chelan County Conservation District monitoring data can be acquired by contacting the Conservation District).

Ecology field personnel collected water quality data during surveys conducted in 2002 and 2003. The methods used in these surveys were initially described in the Quality Assurance Project Plans (Bilhimer et al., 2002 and Bilhimer et al., 2003). However, several stations changed according to logistical needs and information acquired from sampling. Additionally, winter and spring runoff sampling will be added to the Mission, Brender, and Chumstick Creek sampling regime in order to obtain a more complete picture of bacterial contamination in those watersheds (Carroll, 2003). These surveys will occur February through June of 2004. Data from those surveys are not included in this report.

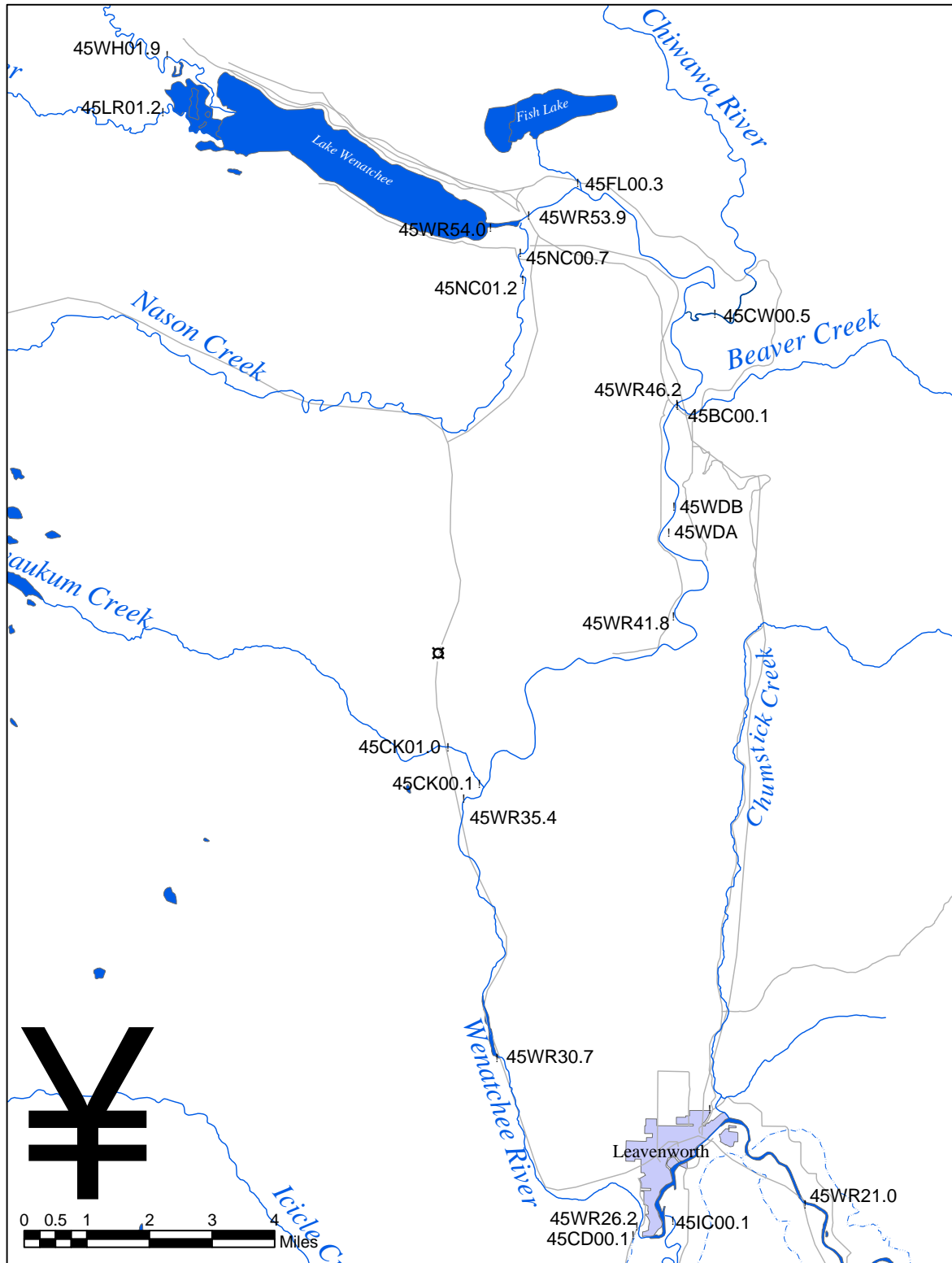


Figure 2. Upper mainstem Wenatchee River (Year 1) sampling stations.

Table 3. Upper mainstem Wenatchee River sample site identification, description, and location.

Station ID (RM included)	Station Name	Category Heading	Long	Lat
45BC00.1	Beaver Cr nr mouth	Grab samples, instantaneous flow	-120.6603	47.7669
45CD00.1	Cascade Orchards Irr Return	Grab samples, continuous flow station	-120.6749	47.5756
45CK00.1	Chiwaukum Cr nr mouth	Grab samples, continuous flow station	-120.7278	47.6795
45CK01.0	Chiwaukum Cr abv campground	Grab samples	-120.7386	47.6880
45CR00.1	Chumstick Irr return nr mouth	Grab samples, instantaneous flow	-120.6488	47.6047
45CW00.5	Chiwawa Cr nr mouth	Grab samples, instantaneous flow	-120.6475	47.7880
45FL00.3	Fish Lake Run nr mouth	Grab samples, instantaneous flow	-120.6946	47.8181
45IC00.1	Icicle Cr at mouth	Grab samples, continuous flow station	-120.6613	47.5789
45LR01.2	Little Wenatchee R nr mouth	Grab samples, instantaneous flow	-120.8370	47.8341
45NC00.7	Nason Cr nr mouth	Grab samples, continuous flow station	-120.7143	47.8020
45NC01.2	Nason Cr abv campground	Grab samples	-120.7134	47.7959
45WDA	Chiwawa Irr return A	Grab samples, instantaneous flow	-120.6632	47.7376
45WDB	Chiwawa Irr return B	Grab samples, instantaneous flow	-120.6614	47.7436
45WH01.9	White R nr mouth	Grab samples, instantaneous flow	-120.8356	47.8472
45WR26.2	Wenatchee R at Leavenworth	Grab samples, instantaneous flow, continuous diurnal data	-120.6736	47.5777
45WR30.7	Wenatchee R at Tumwater Dam	Grab samples	-120.7215	47.6163
45WR35.4	Wenatchee R nr Leavenworth	Grab samples, instantaneous flow, continuous diurnal data	-120.7331	47.6762
45WR41.8	Wenatchee R south of Plain at RR Br	Grab samples, continuous diurnal data	-120.6615	47.7182
45WR46.2	Wenatchee R nr Plain	Grab samples, continuous diurnal data	-120.6605	47.7673
45WR53.9	Wenatchee R blw lake outlet	Grab samples, continuous flow station, continuous diurnal data	-120.7114	47.8107
45WR54.0	Wenatchee R at state park boat launch	Grab samples, continuous diurnal data	-120.7245	47.8079

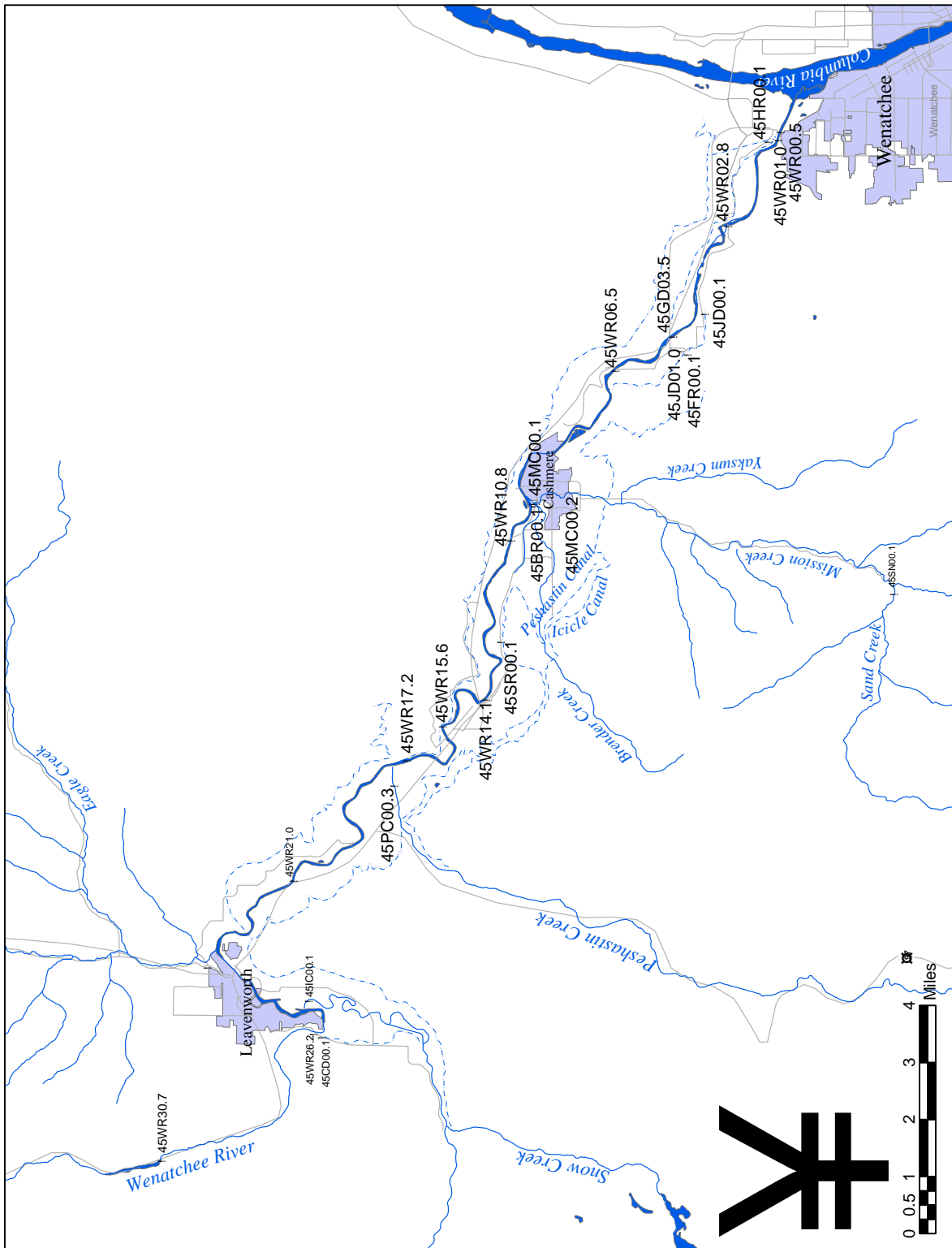


Figure 3. Lower mainstem Wenatchee River (Year 1) sampling stations.

Table 4. Lower mainstem Wenatchee River sample site, identification, description, and location.

Station ID (RM included)	Station Name	Category Heading	Long	Lat
45BR00.1	Brender Cr nr Cashmere	Grab samples, instantaneous flow	-120.4754	47.5214
45CD00.1	Cascade Orchards Irr Return	Grab samples, continuous flow station	-120.6749	47.5756
45CR00.1	Chumstick Irr return nr mouth	Grab samples, instantaneous flow	-120.6488	47.6047
45FR00.1	Icicle Irr return at Fairview Cyn Rd	Grab samples, instantaneous flow	-120.4174	47.4843
45GD03.5	Gunn Ditch at diversion	Grab samples, instantaneous flow	-120.4119	47.4862
45HR00.1	Highline Canal return at mouth	Grab samples, continuous flow station	-120.3390	47.4619
45IC00.1	Icicle Cr at mouth	Grab samples, continuous flow station	-120.6613	47.5789
45JD00.1	Jones Shotwell Ditch at mouth	Grab samples, instantaneous flow	-120.4035	47.4781
45JD01.0	Jones Shotwell Ditch upstream of mouth	Grab samples, instantaneous flow	-120.4185	47.4826
45MC00.1	Mission Cr nr mouth blw Brender	Grab samples, continuous flow station	-120.4748	47.5219
45MC00.2	Mission Cr nr Cashmere	Grab samples, continuous flow station	-120.4748	47.5212
45PC00.3	Peshastin Cr nr mouth	Grab samples, continuous flow station	-120.5804	47.5573
45SR00.1	Stines Hill Icicle Irr return	Grab samples, instantaneous flow	-120.5265	47.5301
45WR00.5	Wenatchee R at Wenatchee	Grab samples, continuous diurnal data	-120.3354	47.4589
45WR01.0	Wenatchee R upstream of mouth	Grab samples, continuous diurnal data	-120.3383	47.4594
45WR02.8	Wenatchee R at Sleepy Hollow Br	Grab samples	-120.3705	47.4722
45WR06.5	Wenatchee R at Old Monitor Br	Grab samples, continuous diurnal data	-120.4247	47.5010
45WR10.8	Wenatchee R nr Cashmere	Grab samples, continuous diurnal data	-120.4882	47.5275
45WR14.1	Wenatchee R abv Olalla	Grab samples, continuous diurnal data	-120.5479	47.5338
45WR15.6	Wenatchee R at PUD rearing pond return	Grab samples	-120.5582	47.5449
45WR17.2	Wenatchee R at Highline diversion	Grab samples, continuous diurnal data	-120.5708	47.5540
45WR21.0	Wenatchee R abv Peshastin	Grab samples, continuous diurnal data	-120.6162	47.5828
45WR26.2	Wenatchee R at Leavenworth	Grab samples, instantaneous flow, continuous diurnal data	-120.6736	47.5777
45WR30.7	Wenatchee R at Tumwater Dam	Grab samples	-120.7215	47.6163

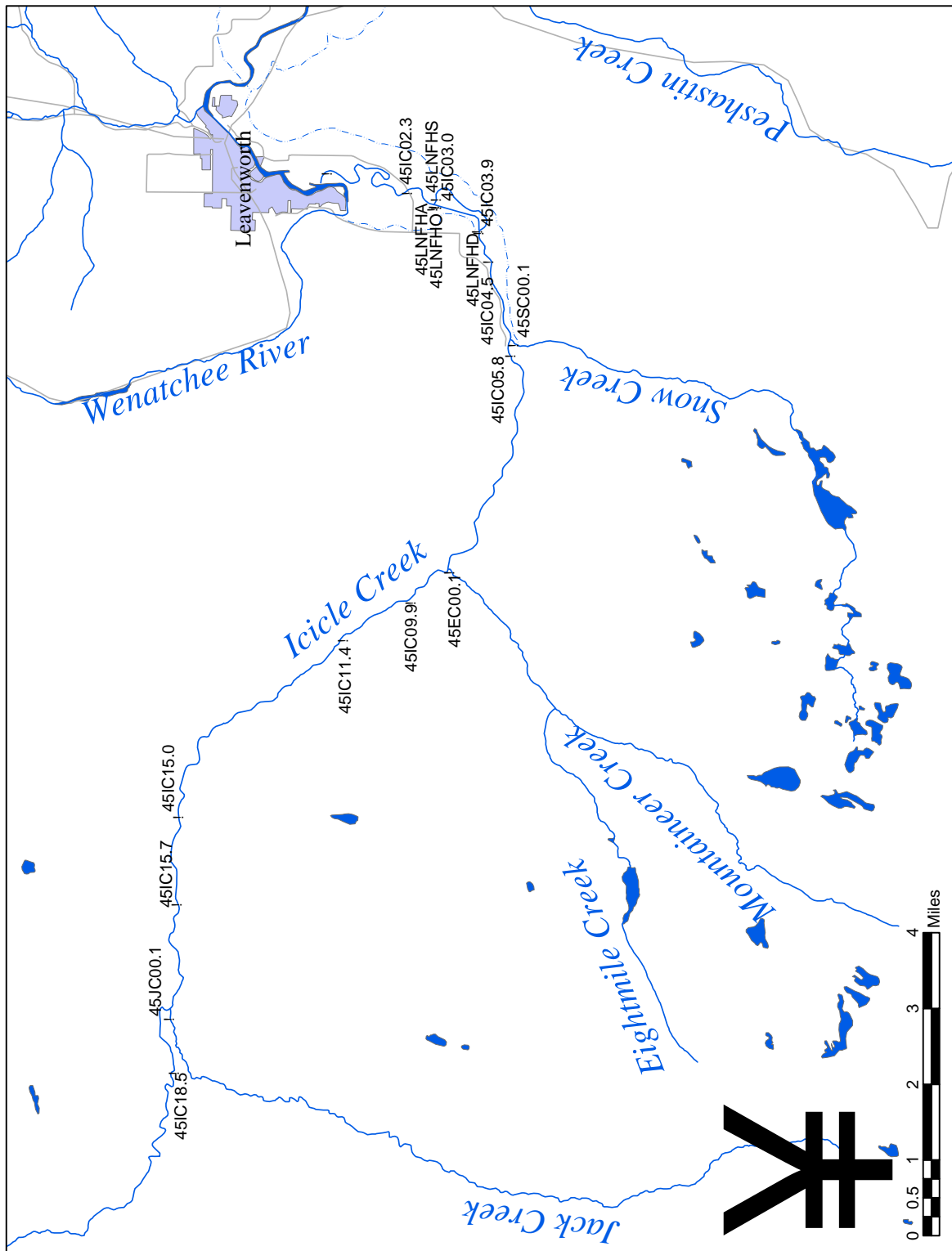


Figure 4. Icicle Creek (Year 1) sampling stations.



Table 5. Icicle Creek sample site identification, description, and location.

Station ID (RM included)	Station Name	Data Category	Long	Lat
45EC00.1	Eightmile Cr nr mouth	Grab samples, instantaneous flow	-120.7739	47.5553
45IC00.1	Icicle Cr at mouth	Grab samples, continuous flow station, continuous diurnal data	-120.6613	47.5789
45IC02.3	Icicle Cr nr Leavenworth	Grab samples, continuous diurnal data	-120.6668	47.5636
45IC03.0	Icicle Cr at hatchery	Grab samples, instantaneous flow	-120.6685	47.5581
45IC03.9	Icicle Cr at LNFH old channel headgate	Grab samples, continuous flow station, continuous diurnal data	-120.6780	47.5499
45IC04.5	Icicle Cr abv LNFH diversion	Grab samples, continuous flow station	-120.6861	47.5480
45IC05.8	Icicle Cr abv Snow Cr	Grab samples	-120.7125	47.5438
45IC09.9	Icicle Cr abv Eightmile Cr	Grab samples, continuous diurnal data	-120.7823	47.5627
45IC11.4	Icicle Cr blw 4th of July Cr	Grab samples	-120.7930	47.5756
45IC15.0	Icicle Cr at Ida Cr Campground	Grab samples	-120.8431	47.6069
45IC15.7	Icicle Cr at Doctor Bob Br	Grab samples	-120.8679	47.6071
45IC18.5	Icicle Cr abv Jack Cr	Grab samples, continuous diurnal data	-120.9154	47.6075
45JC00.1	Jack Cr nr mouth	Grab samples, instantaneous flow	-120.9002	47.6085
45LNFHA	LNFH abatement pond	Grab samples, continuous flow station	-120.6713	47.5587
45LNFHD	LNFH return ditch	Grab samples, instantaneous flow	-120.6777	47.5502
45LNFHO	LNFH outlet	Grab samples, continuous flow station	-120.6707	47.5584
45LNFHS	Icicle Cr main channel blw LNFH spillway	Grab samples	-120.6708	47.5580
45SC00.1	Snow Creek nr mouth	Grab samples, instantaneous flow	-120.7096	47.5432

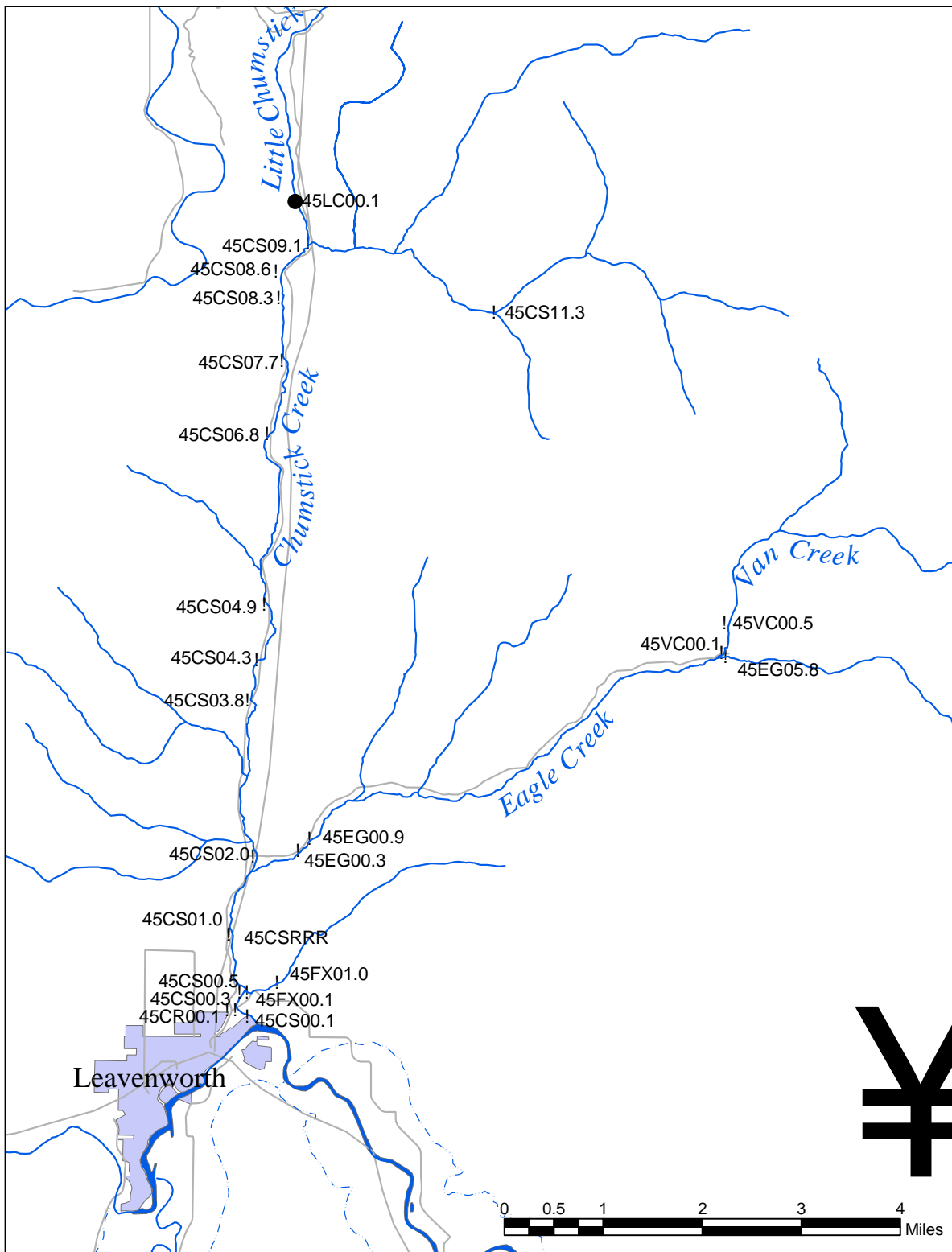


Figure 5. Chumstick Creek (Year 2) sampling stations.

Table 6. Chumstick Creek sample site identification, description, and location.

Station ID (includes RM)	Station Name	Data Category	Long	Lat
45CR00.1	Chumstick Irr return nr mouth	Grab samples, instantaneous flow	-120.6488	47.6047
45CS00.1	Chumstick Cr at mouth	Grab samples, continuous flow station	-120.6470	47.6048
45CS00.3	Chumstick Cr nr mouth	Grab samples, instantaneous flow	-120.6444	47.6038
45CS00.5	Chumstick Cr nr Leavenworth	Grab samples, instantaneous flow	-120.6461	47.6073
45CS01.0	Chumstick Cr abv River Riders return	Grab samples, instantaneous flow	-120.6484	47.6158
45CS02.0	Chumstick Cr abv Eagle Cr	Grab samples, instantaneous flow	-120.6433	47.6272
45CS03.8	Chumstick Cr blw midstream	Grab samples, instantaneous flow	-120.6445	47.6500
45CS04.3	Chumstick Cr midstream	Grab samples, instantaneous flow	-120.6425	47.6559
45CS04.9	Chumstick Cr midstream at Hwy 209	Grab samples, instantaneous flow	-120.6409	47.6640
45CS06.8	Chumstick Cr at br blw Camp 12 Rd	Grab samples, instantaneous flow	-120.6404	47.6889
45CS07.7	Chumstick Cr at Camp 12 Rd	Grab samples, instantaneous flow	-120.6372	47.6997
45CS08.3	Chumstick Cr blw Ott property	Grab samples, instantaneous flow	-120.6379	47.7088
45CS08.6	Chumstick Cr nr railroad br	Grab samples, instantaneous flow	-120.6385	47.7127
45CS09.1	Chumstick cr abv Little Chumstick Cr	Grab samples, instantaneous flow	-120.6316	47.7168
45CS11.3	Chumstick Cr abv Second Cr	Grab samples, instantaneous flow	-120.5913	47.7067
45CSRRR	Icicle Irrigation return at River Riders	Grab samples, instantaneous flow	-120.6485	47.6157
45EG00.3	Eagle Cr nr mouth	Grab samples, instantaneous flow	-120.6335	47.6280
45EG00.9	Eagle Cr abv mouth	Grab samples, instantaneous flow	-120.6310	47.6298
45EG05.8	Eagle Cr abv Van Cr	Grab samples, instantaneous flow	-120.5411	47.6565
45FX00.1	Fox Irr return nr mouth	Grab samples, instantaneous flow	-120.6445	47.6073
45FX01.0	Fox Irr return at Fox Cyn	Grab samples, instantaneous flow	-120.6380	47.6088
45LC00.1	Little Chumstick Cr nr mouth	Grab samples, instantaneous flow	-120.6336	47.7205
45VC00.1	Van Cr at mouth	Grab samples, instantaneous flow	-120.5420	47.6570
45VC00.5	Van cr abv private property	Grab samples, instantaneous flow	-120.5414	47.6614

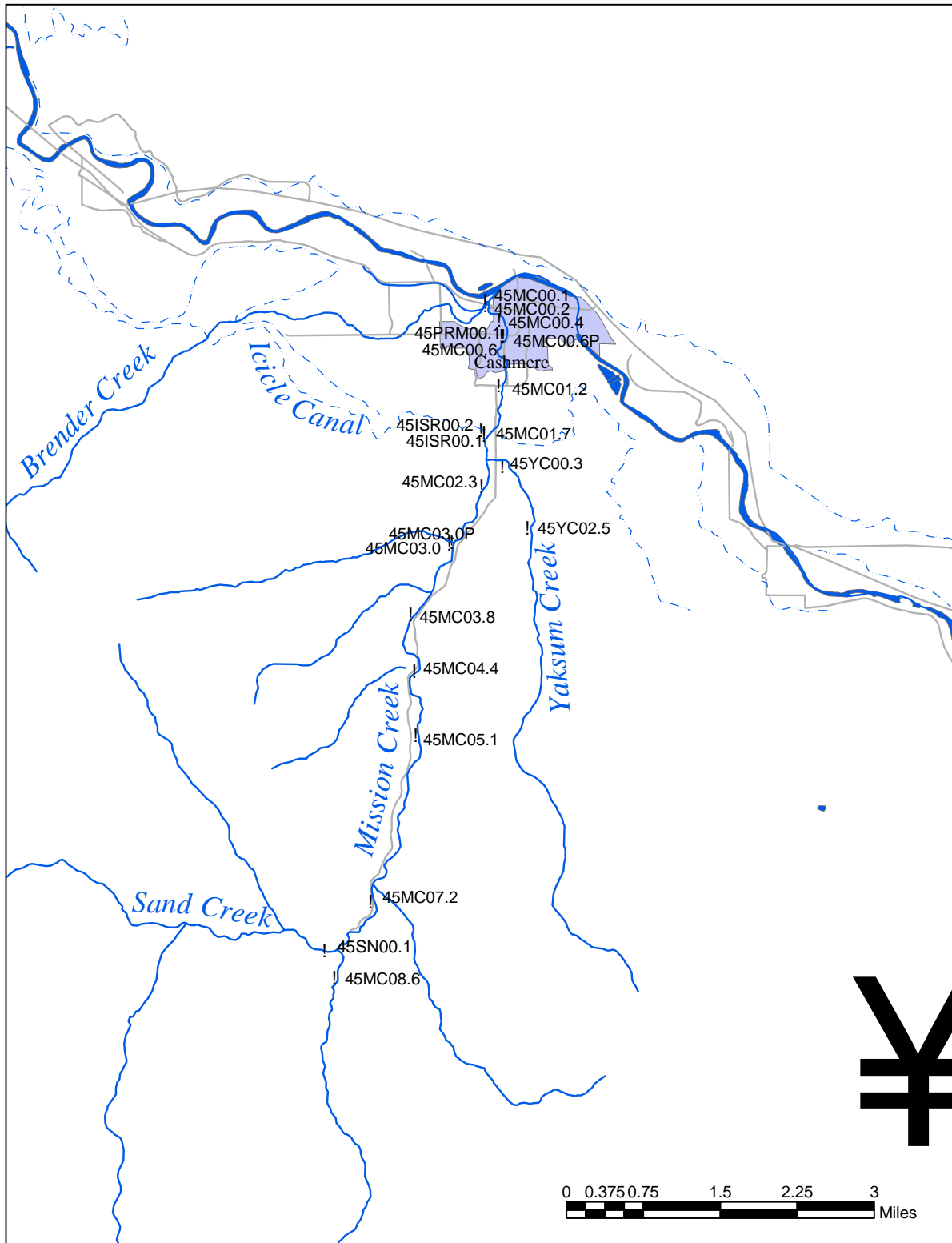


Figure 6. Mission Creek (Year 2) sampling stations.

Table 7. Mission Creek sample site identification, description, and location.

Station ID (RM included)	Station Name	Data Category	Long	Lat
45MC08.6	Mission Cr on USFS Land	Grab samples, instantaneous flow	-120.5063	47.4263
45MC00.1	Mission Cr nr mouth blw Brender	Grab samples, continuous flow station	-120.4748	47.5219
45MC00.2	Mission Cr nr Cashmere	Grab samples, continuous flow station	-120.4748	47.5212
45ISR00.1	Icicle Irr return at Thomas property	Grab samples, instantaneous flow	-120.4751	47.5033
45ISR00.2	Icicle Irr return above Thomas property	Grab samples, instantaneous flow	-120.4757	47.5036
45MC00.4	Mission Cr at Angier Rd	Grab samples, instantaneous flow	-120.4719	47.5192
45MC00.6	Mission Cr at Pioneer Ave	Grab samples, instantaneous flow	-120.4711	47.5170
45MC00.6P	Pipe at Mission Cr at Pioneer Ae	Grab samples, instantaneous flow	-120.4713	47.5170
45MC00.9	Mission Cr at Creekside Pl	Grab samples, instantaneous flow	-120.4716	47.5136
45MC01.2	Mission Cr at Binder Rd	Grab samples, continuous flow station	-120.4720	47.5099
45MC01.7	Mission Cr abv Icicle Spill Return	Grab samples, instantaneous flow	-120.4751	47.5029
45MC02.3	Mission Cr abv Yaksum Cr	Grab samples, instantaneous flow	-120.4756	47.4957
45MC03.0	Mission Cr at Tripp Cyn	Grab samples, instantaneous flow	-120.4823	47.4876
45MC03.0P	Pipe at Mission Cr at Tripp Cyn	Grab samples, instantaneous flow	-120.4818	47.4878
45MC03.8	Mission Cr blw Sherman Cyn	Grab samples, instantaneous flow	-120.4904	47.4776
45MC04.4	Mission Cr at Sherman Cyn (Shelton property)	Grab samples, instantaneous flow	-120.4896	47.4696
45MC05.1	Mission Cr blw Bear Gulch	Grab samples, instantaneous flow	-120.4893	47.4605
45MC07.2	Mission Cr abv Bear Gulch	Grab samples, instantaneous flow	-120.4987	47.4370
45PRM00.1	Peshastin upstream irr return	Grab samples, instantaneous flow	-120.4714	47.5170
45SN00.1	Sand Creek nr mouth	Grab samples, instantaneous flow	-120.5072	47.4297
45YC02.5	Upper Yaksum Creek	Grab samples, instantaneous flow	-120.4660	47.4898
45YC00.3	Yaksum Creek nr mouth	Grab samples, instantaneous flow	-120.4712	47.4985

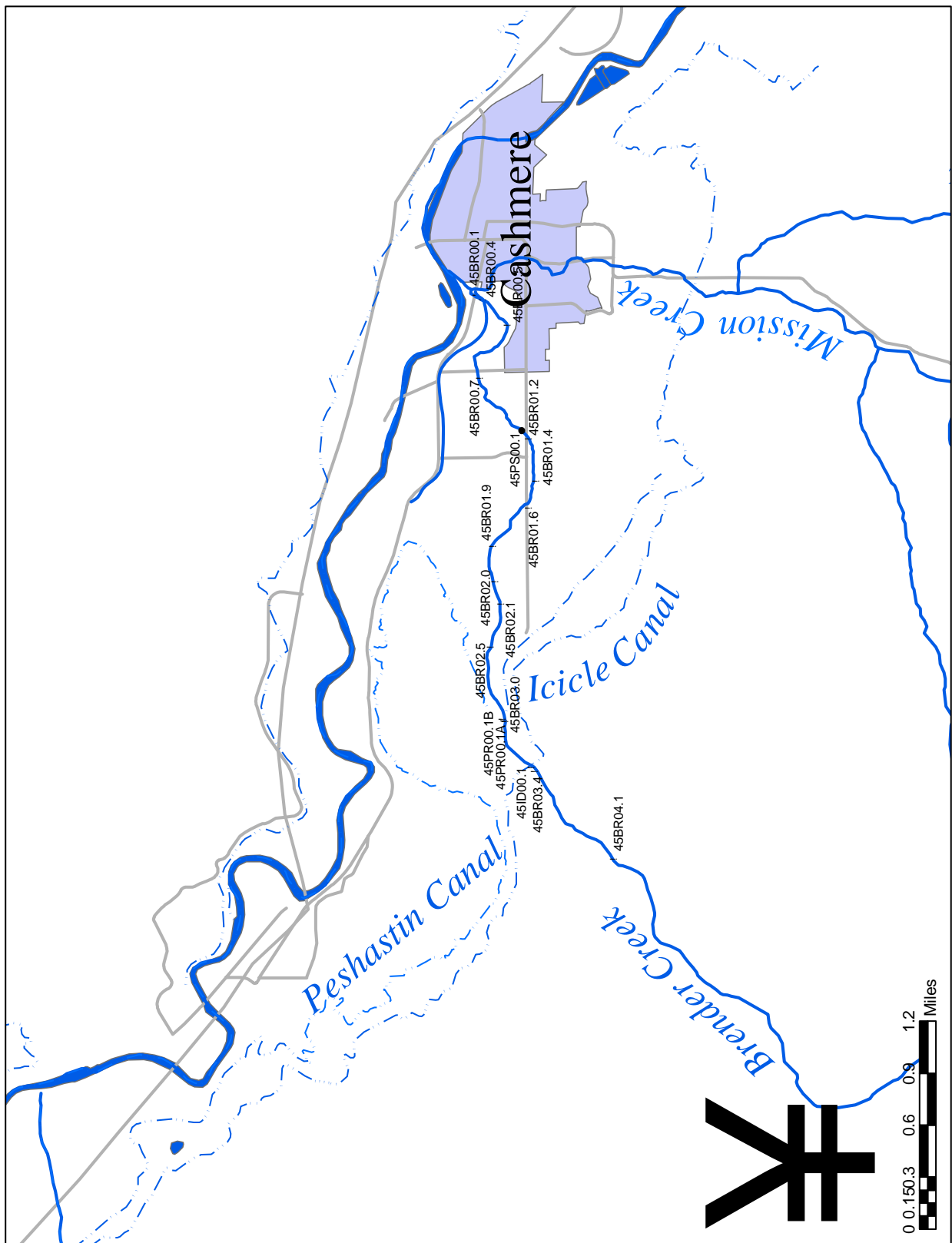


Figure 7. Brender Creek (Year 2) sampling stations.

Table 8. Brender Creek sample site identification, description, and location.

Station ID (RM included)	Station Name	Data Category	Long	Lat
45BR00.1	Brender Cr nr Cashmere	Grab samples, instantaneous flow	-120.4754	47.5214
45BR00.4	Brender Cr abv mouth	Grab samples, continuous flow station	-120.4759	47.5208
45BR00.5	Brender Cr blw sediment pond	Grab samples, instantaneous flow	-120.4790	47.5188
45BR00.7	Brender Cr at Evergreen Dr	Grab samples, instantaneous flow	-120.4856	47.5211
45BR01.2	Brender Cr at Pioneer Ave DS	Grab samples, instantaneous flow station	-120.4931	47.5170
45BR01.4	Brender Cr at Hinman Rd	Grab samples, instantaneous flow	-120.4983	47.5164
45BR01.6	Brender Cr at Pioneer Ave US	Grab samples, instantaneous flow	-120.5016	47.5170
45BR01.9	Brender Cr at Bailey property	Grab samples, instantaneous flow	-120.5063	47.5200
45BR02.0	Brender Cr at Warman property	Grab samples, instantaneous flow	-120.5107	47.5198
45BR02.1	Brender Cr at Mattson property	Grab samples, instantaneous flow station	-120.5134	47.5193
45BR02.5	Brender Cr at Jurgens property	Grab samples, instantaneous flow	-120.5188	47.5202
45BR03.0	Brender Cr abv Peshastin Irr returns	Grab samples, instantaneous flow	-120.5279	47.5190
45BR03.4	Brender Cr abv US Icicle Irr Return	Grab samples, instantaneous flow	-120.5341	47.5165
45BR04.1	Brender Cr at Brender Rd	Grab samples, instantaneous flow	-120.5449	47.5099
45ID00.1	Icicle Irr district upstream return	Grab samples, instantaneous flow	-120.5336	47.5168
45PS00.1	Peshastin Irr district spill return at Pioneer Rd.	Grab samples, instantaneous flow	-120.4933	47.5171
45PR00.1A	Peshastin Irr return (pipe)	Grab samples, instantaneous flow	-120.5277	47.5192
45PR00.1B	Peshastin Irr return (box)	Grab samples, instantaneous flow	-120.5278	47.5191

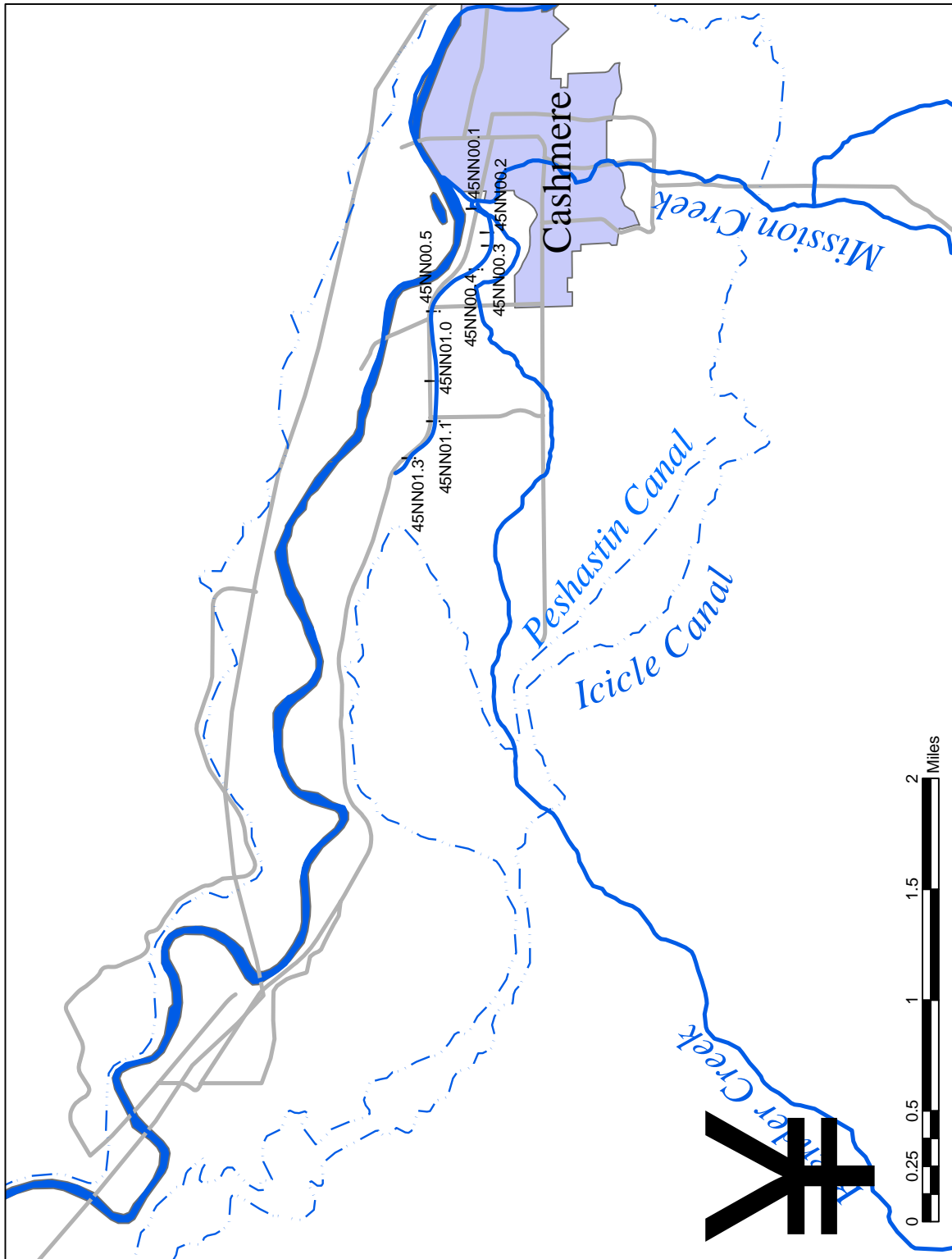


Figure 8. No Name Creek (Year 2) sampling stations.



Table 9. No Name Creek sample site identification, description, and location.

Station ID (RM included)	Station Name	Data Category	Long	Lat
45NN00.1	No Name Cr at mouth	Grab samples, instantaneous flow	-120.4752	47.5217
45NN00.2	No Name Cr at Mill Rd	Grab samples, instantaneous flow	-120.4775	47.5208
45NN00.3	No Name Cr blw duck pond	Grab samples, instantaneous flow	-120.4788	47.5207
45NN00.4	No Name Cr abv duck pond	Grab samples, instantaneous flow	-120.4811	47.5215
45NN00.5	No Name Cr at Sunsant Hwy	Grab samples, instantaneous flow	-120.4851	47.5243
45NN01.0	No Name Cr at Locust Ln	Grab samples, instantaneous flow	-120.4918	47.5244
45NN01.1	No Name Cr at Wescott Dr	Grab samples, instantaneous flow	-120.4957	47.5243
45NN01.3	No Name Cr at Turkey Shoot Rd	Grab samples, instantaneous flow	-120.4992	47.5259

All river water quality samples collected for laboratory analysis were grab samples taken just below the water surface from the main body of flow (unless there was not enough depth to submerge the sample container). Samples were collected either by using an extension rod extended from the stream bank or by wading into the river. Generally, for half of the Mission, Brender and Chumstick creek surveys, grab samples were collected twice a day (morning and afternoon); for the remaining half, grab samples were collected once per day.

Instantaneous river temperature, DO, pH and conductivity were measured using Hydrolab® Datasonde 3s and 4s. Hydrolab® DO measurements were compared to DO measurements using the azide modified Winkler method.

*In situ* multi-parameter data loggers (Hydrolab® Datasonde 3s and 4s) were deployed at different locations in the mainstem Wenatchee River and Icicle Creek during Year 1 (June 2002 through April 2003) to collect continuous diurnal data for DO, temperature, pH, and conductivity. The locations with diurnal data are listed in Tables 3 through 9. These data were used to assess diurnal changes in the parameters measured.

Point sources listed in the QAPPs were sampled during the Year 1 intensive synoptic surveys by Ecology's Toxics Studies Unit. Appendix A lists the permit limits and background information of the Wenatchee TMDL point sources. Final effluents were sampled during periods when they discharge to receiving waters. Two grab samples per day were collected as well as 24-hour composite samples. Appendix B contains a summary of the field notes from the point source sampling describing the sample collection and field measurements.

Groundwater methodology and results will be included in a separate report.

# Sampling and Quality Control Procedures

All water samples for laboratory analysis were collected in pre-cleaned containers supplied by Ecology's Manchester Environmental Laboratory (MEL), except dissolved organic carbon, dissolved total phosphorus, and ortho-phosphorus which were collected in a syringe and filtered into a pre-cleaned container. The syringe was rinsed with ambient water at each sampling site three times before filtering. All samples for laboratory analysis were preserved as specified by MEL (2000) and delivered to MEL within 24 hours of collection. Laboratory analyses listed in Table 1b were performed in accordance with MEL (2000).

Field sampling and measurement protocols followed those specified in WAS (1993) for *in situ* temperature, DO, pH, and specific conductance (Hydrolab® multi-parameter meters) and for DO Winkler titrations. All meters were calibrated and post-calibrated per manufacturer's instructions.

Effluent samples from the point sources were collected in pre-cleaned ISCO 24-hour composite samplers. Effluent sampling was conducted according to standard operating procedures for Class II inspections by Ecology as documented in Glenn (1994). Appendix B contains a summary of the field notes from the point source sampling describing the sample collection and field measurements. Groundwater data collected by Ecology followed protocols defined in Garrigues (1999).

Replicate samples were collected to assess total field and laboratory variation. Blanks were also used to assess possible sample contamination. Replicate and blank samples were introduced in the field and submitted "blind" with the routine batches of samples to the laboratory.

Phytoplankton samples were preserved with 1% Lugol's solution immediately after collection and sent to Jim Sweet, Aquatic Analysts, Wilsonville, Oregon, for plankton analyses.

# Data Quality Results

## Data Quality Assurance Objectives

Data collected for this Wenatchee River TMDL Study were evaluated to determine whether data quality QA/QC objectives for the project were met. Water quality data QA/QC objectives for precision, bias, and accuracy are described in Table 2. Year 2 data collection is incomplete to date and will be updated later.

## Sample Quality Assurance

### QA/QC for Samples

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#### Field Sampling QA/QC

Field sampling protocols followed those specified in WAS (1993). Field QC requirements include the use of field replicates and field blanks to assess total precision and field bias, respectively. Sample-collection protocols were compromised at times during Year 2 because of low flow in the tributaries (see below).

#### Laboratory QA/QC

MEL was used for all laboratory analyses. Laboratory data were generated according to QA/QC procedures described in MEL (2000). MEL prepared and submitted QA memos to the EA Program for each sampling survey. Each memo summarized the QC procedures and results for sample transport and storage, sample holding times, and instrument calibration. The memo also included a QA summary of check standards, matrix spikes, method blanks (used to check for analytical bias) and lab-split samples (used to check for analytical precision).

With few exceptions (described below), all samples were received in good condition and were properly preserved, as necessary. The temperature of the shipping coolers was between proper ranges of 2°C - 6°C for all sample shipments except 2 coolers received at MEL on July 25, 2002. On that day, one cooler had an ambient temperature of 7°C and another cooler had an ambient temperature of 8°C; however, the samples for that date were not qualified for being out of range.

Holding times were violated at times throughout the project because of delayed transport problems or because the samples were held too long at MEL before analysis. MEL qualified as estimates all individual samples that were analyzed beyond holding times with a “J”.

Instrument calibration and control checks were all within control limits for the project. Lower reporting limit objectives were met for all parameters except TP for the November 12 and 13, 2002 survey (TP on that survey had a reporting limit of 10 ug/L instead of 3 ug/L). Results not detected at or above the reporting limits listed in Table 2 were qualified by MEL with a “U”.

Data below the reporting limit were excluded from consideration in determining analytical and total precision (see below).

For the most part, data quality for this project met all lab QA/QC criteria as determined by MEL. Individual exceptions that caused the results to be qualified as an estimate were qualified by MEL with a “J” qualifier in the data tables. All qualifications will be taken into consideration for the purpose of data analysis. Data precision, bias, and accuracy for all parameters were compared separately below to the project data quality objectives listed in Table 2.

## Precision

### Analytical Precision

Analytical laboratory precision was determined separately in order to account for its contribution to overall variability. Laboratory split samples were analyzed at least once per batch (or about 10% of the total) to assess analytical precision. A pooled relative standard deviation (%RSD) was calculated for each parameter using lab-split results greater than reporting limits. %RSD was calculated by first calculating a pooled standard deviation as the square of the sum of the squared differences divided by two times the number of pairs. Then the pooled standard deviation was divided by the mean of the replicate measurements and then multiplied by 100 for the %RSD. Higher %RSD is expected for values that are close to their reporting limit (e.g., the %RSD for replicate samples with results of 1 and 2 is 47%, whereas the %RSD for replicate results of 100 and 101 is 0.7%).

Because higher %RSD is expected near the reporting limit, two tiers were also evaluated; lab-split results less than five times the reporting limit were considered separately from lab-splits results equal to or more than five times the reporting limit (for FC bacteria, the two tiers were less than 50 and greater than or equal to 50 cfu/100mL). The %RSD in the upper tier was compared to the target precision objective for each parameter. Analytical precision for all parameters was below the target precision objectives for both years. Results are listed in Tables 10 and 11 for each study year.

Table 10. Lab precision for Year 1 results. Results at the detection limit were excluded from consideration.

Parameter	Target Precision %RSD	Average %RSD for samples <5X reporting limit (number of duplicate pairs)	Average %RSD for samples ≥5X reporting limit (number of duplicate pairs)
Alkalinity	<10	3.3 (21)	0.7 (24)
Ammonia-Nitrogen	<10	0.0 (1)	0.8 (2)
BOD	<25	0.0 (2)	10.6 (3)
Chloride	<5	6.7 (13)	0.3 (11)
Chlorophyll	<20	6.0 (2)	6.5 (17)
Dissolved Organic Carbon	<10	8.8 (5)	2.4 (2)
Fecal coliform <sup>1</sup>	<25	35.6 (19)	15.5 (2)
Nitrite-Nitrate Nitrogen	<10	2.0 (10)	1.8 (11)
Ortho-phosphate	<10	6.5 (16)	8.1 (5)
Total Dissolved Solids	<10	all samples >5X reporting limit	1.9 (35)
Total Nonvolatile Suspended Solids	<10	11.3 (7)	4.6 (4)

Total Organic Carbon	<10	7.0 (19)	1.4 (4)
Total Phosphorus	<10	10.4 (20)	4.4 (7)
Total Persulfate Nitrogen	<10	12.3 (14)	6.2 (13)
Total Suspended Solids	<10	0.0 (11)	3.9 (8)
Turbidity	<10	6.3 (13)	1.7 (6)

<sup>1</sup>Bacteria duplicates are split into samples <50cfu/100mL and ≥50cfu/100 mL

Table 11. Lab precision for Year 2 results. Results at the detection limit were excluded from consideration.

Parameter	Target Precision %RSD	Average %RSD for samples <5X reporting limit (number of duplicate pairs)	Average %RSD for samples ≥5X reporting limit (number of duplicate pairs)
Chloride	<5	all samples >5X reporting limit	1.0 (24)
Fecal coliform <sup>1</sup>	<25	20.2 (20)	16.2 (39)
Total Suspended Solids	<10	6.9 (14)	5.2 (24)

<sup>1</sup>Bacteria duplicates are split into samples <50cfu/100mL and ≥50cfu/100 mL

## Total Precision

Field replicate samples were collected for at least 10% of the total number of general chemistry samples and at least 20% of the total number of microbiology samples in order to assess total precision (i.e., total variation) for field samples. As was done for the lab precision evaluation, two tiers were also evaluated for total precision; field-replicate results less than five times the reporting limit and field-replicate results equal to or more than five times the reporting limit (for FC bacteria, the two tiers were less than 50 and greater than or equal to 50 cfu/100mL). A pooled relative standard deviation (%RSD) was calculated for each parameter using field replicate results greater than reporting limits. Results are listed in Tables 12 and 13 for each study year.

Table 12. Total precision (field + lab) for Year 1 results. Results at the detection limit were excluded from consideration.

Parameter	Target Precision %RSD	Average %RSD for samples <5X reporting limit (number of duplicate pairs)	Average %RSD for samples ≥5X reporting limit (number of duplicate pairs)
Alkalinity	<10	1.8 (19)	1.9(23)
Ammonia-Nitrogen	<10	11.9 (5)	2.5 (1)
Chloride	<5	5.6 (11)	4.9 (18)
Chlorophyll	<20	12.3 (1)	13.6 (19)
Dissolved Organic Carbon	<10	all samples >5X reporting limit	9.7 (7)
Fecal coliform <sup>1</sup>	<25	25.3 (13)	15.1 (1)
Nitrite-Nitrate Nitrogen	<10	2.2 (13)	4.5 (11)
Ortho-phosphate	<10	15.9 (26)	0.4 (4)
Total Dissolved Solids	<10	all samples >5X reporting limit	5.4 (26)
Total Nonvolatile Suspended Solids	<10	20.0 (4)	8.7 (4)
Total Organic Carbon	<10	10.2 (21)	all samples <5X reporting limit
Total Phosphorus	<10	15.1 (17)	5.7 (6)
Total Persulfate Nitrogen	<10	16.7 (14)	5.2 (17)

Total Suspended Solids	<10	12.0 (12)	22.9 (9)
Turbidity	<10	13.6 (16)	12.3 (9)

<sup>1</sup>Bacteria duplicates are split into samples <50cfu/100mL and ≥50cfu/100 mL

Table 13. Total precision (field + lab) for Year 2 results. Results at the detection limit were excluded from consideration.

Parameter	Target Precision %RSD	Average %RSD for samples <5X reporting limit (number of duplicate pairs)	Average %RSD for samples ≥5X reporting limit (number of duplicate pairs)
Chloride	<5	7.1 (1)	30.9 (37)
Fecal coliform <sup>1</sup>	<25	39.9 (22)	53.7 (88)
Total Suspended Solids	<10	55.0 (16)	44.0 (14)

<sup>1</sup>Bacteria duplicates are split into samples <50cfu/100mL and ≥50cfu/100 mL

Total precision %RSD in the upper tier was compared to the target precision. As expected, %RSD for field replicates was generally higher than that for lab-splits because it is a measurement of total variability, including both field and analytical variability.

For Year 1 results, the %RSD for all parameters met the target precision objectives except for total suspended solids and turbidity. The analytical precision for total suspended solids and turbidity was very good so most of the variability appears to be field variability. Total suspended solid concentrations are inherently variable because of patchy distributions in the environment and intermittent discharge. Total suspended solids and turbidity data were not qualified but the data variability for the two parameters will be taken into consideration when using the data for modeling and other analyses, and interpreting results.

During Year 2, the %RSD for chloride, FC bacteria, and total suspended solids data did not meet the target precision objectives. The analytical precision for these parameters was very good so most of the variability appears to be field variability. Bacterial populations, as well as suspended solid concentrations and turbidity, are inherently variable because of patchy distributions in the environment and intermittent discharge.

The Year 2 sampling was conducted on Mission, Brender, No Name, and Chumstick creeks during low flow. Low flow conditions compromised sample-collection protocols and may have exacerbated variability. Standardized field sampling is employed to reduce variability of samples. WAS (1993) sampling protocols caution against sampling the surface of the water because a micro-layer of bacteria tends to occur there; however, during the Year 2 sampling, many grab samples unavoidably included the surface of the water because of a lack of water depth to submerge the collection bottles.

However, high variability was also present in replicate samples taken during higher flows in Year 2, so the lower precision data seems more indicative of generally high variability in the tributaries. The target precision objective for the project may have been too low for the tributaries. The Year 2 data were not qualified for not meeting the target precision objectives; however the high variability of the data will be taken into consideration for modeling, analysis, and interpreting results.

## Bias

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### Analytical Bias

Analytical bias was evaluated using method blanks, laboratory check standards, and matrix spikes. Each of these control samples were run once per batch or every 20 samples. Method blanks for all parameters were below reporting limits for the entire project with the following exceptions:

- One method blank sample run with a batch of chlorophyll a samples collected on August 27, 2002 had a value slightly above reporting limit. The entire batch was qualified as an estimate (denoted by “J”) due to other instrumentation problems, however.
- Over one third of the method blanks samples for total dissolved solids (TDS) batch analyses were slightly above reporting limits (1-3 mg/L; reporting limit =1 mg/L). There were no qualifications of TDS data.

Pooled laboratory check standard deviations and matrix spike recoveries were compared to the target maximum bias for each applicable parameter in Table 14. Analytical bias was considered acceptable for all of the parameters.

Table 14. Pooled analytical bias by parameter for Year 1 and 2 results.

Parameter	Target Bias (maximum % deviation from true value)	Pooled % recovery of matrix spike addition to sample	Pooled % deviation from true value of laboratory control sample
Alkalinity	5	1.6	2.5
Ammonia-Nitrogen	5	1.2	4.7
Chloride	5	5.2	2.7
Chlorophyll	10	N/A	3.3
Dissolved Organic Carbon	10	8.1	5.7
Nitrite-Nitrate Nitrogen	5	2.6	2.0
Ortho-phosphate	5	2.4	5.5
Total Dissolved Solids	10	N/A	1.5
Total Organic Carbon	10	4.8	4.8
Total Phosphorus	5	2.1	4.7
Total Persulfate Nitrogen	10	4.7	3.3
Total Suspended Solids	10	N/A	2.4
Turbidity	10	N/A	1.2

### Field Bias

Field-blank samples were submitted to Manchester Laboratory blindly in order to determine bias from contamination in the field. Results are presented in Table 15. Field-blank contamination was suspected when measured values exceeded the corresponding reporting limits. With the exception of three samples (see below), all submitted field-blank measurement values were below reporting limits.



Table 15. Field blank results. Results qualified with “U” or “UJ” were not detected at the reporting limit.

Parameter	Date	Result		
Alkalinity	07/24/02	5	mg/L	U
	08/28/02	5	mg/L	U
	09/25/02	5	mg/L	U
Ammonia-Nitrogen	07/24/02	0.01	mg/L	U
	08/28/02	0.01	mg/L	U
	09/25/02	0.01	mg/L	U
Chlorides	07/24/02	0.1	mg/L	U
	08/28/02	0.1	mg/L	U
	09/25/02	0.1	mg/L	UJ
Chlorophyll	07/24/02	0.05	ug/L	U
	08/28/02	0.05	ug/L	UJ
	09/25/02	0.05	ug/L	U
Dissolved Organic Carbon	07/24/02	1	mg/L	U
	08/28/02	1	mg/L	U
	09/25/02	3.7	mg/L	
E. coli	07/24/02	1	#/100 mL	U
	08/28/02	8	#/100 mL	U
	09/25/02	3	#/100 mL	U
Fecal coliform	07/24/02	1	#/100 mL	U
	08/28/02	8	#/100 mL	U
	09/25/02	3	#/100 mL	U
Nitrite-Nitrate Nitrogen	07/24/02	0.012	mg/L	
	08/28/02	0.01	mg/L	UJ
	09/25/02	0.01	mg/L	U
Ortho-phosphate	07/24/02	0.003	mg/L	U
	08/28/02	0.003	mg/L	U
	09/25/02	0.003	mg/L	U
Total Dissolved Solids	07/24/02	1.0	mg/L	U
	08/28/02	1.0	mg/L	U
Total Non-Volatile Suspended Solids	07/24/02	0.010	mg/L	U
	08/28/02	0.010	mg/L	U
Total Organic Carbon	07/24/02	1.0	mg/L	U
	08/28/02	1.0	mg/L	U
	09/25/02	3.7	mg/L	
Total Persulfate Nitrogen	07/24/02	0.025	mg/L	U
	08/28/02	0.025	mg/L	U
	09/25/02	0.025	mg/L	U
Total Phosphorus (TP), Low-level	07/24/02	3	ug/L	U
	08/28/02	3	ug/L	U
	9/25/02	3	ug/L	U
TP, Low-level – dissolved	07/24/02	3	ug/L	U
	08/28/02	3	ug/L	U
Total Suspended Solids	07/24/02	1	mg/L	U
	08/28/02	1	mg/L	U
	09/25/02	1	mg/L	U
Turbidity	07/24/02	0.5	NTU	U
	08/28/02	0.5	NTU	U
	09/25/02	0.5	NTU	U

NO<sub>2</sub>-NO<sub>3</sub> was measured above the reporting limit in a field-blank sample from July 24, 2002. A review of laboratory QA/QC for NO<sub>2</sub>-NO<sub>3</sub> on that date showed no laboratory bias or contamination. Since the measured value of the field-blank was just slightly above the reporting limit, no correction or qualification was made to NO<sub>2</sub>-NO<sub>3</sub> results for that date.

TOC and DOC were measured above their reporting limits in field-blank samples submitted on September 25, 2002. A review of laboratory QA/QC for TOC and DOC on that date showed no laboratory bias or contamination. Other samples with measurable results above the reporting limits from that date did not have evidence of contamination (i.e., sample results were below the field-blank results). In reviewing all of the field and laboratory quality control data it does not appear that there was any contamination or bias in either the sampling or analytical procedures, therefore no qualifications or corrections were made for TOC or DOC results from that date.

## Accuracy

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Accuracy is defined as two times the precision %RSD plus the bias. The higher-tier %RSD (except TOC) and the higher of the analytical biases (matrix spike recoveries and lab control samples deviation) were used to calculate the accuracy. TSS and chloride from Year 2 were not considered in this evaluation. Accuracy targets and results are presented in Table 16. All accuracy targets were met for each parameter except TSS. The high variability associated with all TSS data will be taken into consideration when using the data for modeling, analyses, and interpretation of results.

Table 16. Accuracy results compared to target accuracy objectives for Year 1 and 2 results.

Parameter	Target Accuracy (maximum % deviation from true value)	Observed accuracy (calculated as 2 X precision %RSD plus bias)
Alkalinity	25	6.3
Ammonia-Nitrogen	25	9.7
Chloride	15	15
Chlorophyll	50	30.5
Dissolved Organic Carbon	30	27.5
Nitrite-Nitrate Nitrogen	25	11.6
Ortho-phosphate	25	6.3
Total Dissolved Solids	30	12.3
Total Organic Carbon	30	25.2
Total Phosphorus	25	16.1
Total Persulfate Nitrogen	30	15.1
Total Suspended Solids	30	48.2
Turbidity	30	25.8

## Field Measurement Quality Assurance

Field measurement protocols followed those specified in WAS (1993) for DO (Winkler titration), streamflow (Marsh-McBirney, 2000), and *in situ* temperature, DO, pH, and specific conductance (Hydrolab® multi-parameter meters).

Hydrolab® meters were used for taking instantaneous measurements and were also used to capture continuous measurements. Meters were pre- and post-calibrated for pH, DO, and conductivity. The manufacturer's instructions were followed for pH and conductivity calibration, using pH 7 and pH 10 standard buffer solutions and 100 umhos/cm conductivity standard solution. The DO sensor was pre-calibrated to theoretical water-saturated air, in accordance with manufacturer's instructions. Winkler field samples were collected daily for use as DO check standards. If necessary, Winkler DO measurements were used to adjust meter data (see below).

## Precision

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Replicate or duplicate measurements were not taken for instantaneous or continuous field measurements so there was not an assessment of precision for these measurements. All measurements made with meters were taken *in situ* and the meter was allowed to equilibrate to a stable reading, in the case for an instantaneous reading, or was given a 2 minute equilibration period before a reading was recorded, as in the case for a continuous reading. Continuous readings were generally 30 minutes apart and were conducted for 12 to 24 hours or longer.

## Bias

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### **Instantaneous Measurement Bias**

The average difference of post-calibration pH readings was 0.07 standard pH units (s.u.) with a standard deviation of 0.1 s.u. The pooled bias for all of the post-calibration instantaneous pH readings was 0.09 s.u. (the target bias was less than 0.1 s.u.). All instantaneous pH readings were considered acceptable except five pH readings from July 21, 2003 which were qualified as estimates due to a problem with the meter that morning.

Post-calibration checks for instantaneous conductivity measurements had a pooled %RSD bias of 3.4%, well under the target maximum bias of 5%. All instantaneous conductivity measurements were considered acceptable for use without qualification.

Hydrolab® instantaneous DO data was compared to Winkler check standards to assess bias. In most cases there was a slight adjustment (correction factor) applied to the meter DO data and there was no qualification designated.

### *Year 1 Instantaneous DO Bias*

The average adjustment for Year 1 instantaneous DO data was -0.13 mg/L (pooled standard deviation of 0.29 mg/L) with a pooled %RSD of 2.7%, well below the target maximum bias of 5%. For several Year 1 sampling dates, instantaneous DO results were rejected or qualified due to poor correlation between Hydrolab and Winkler values, or malfunctioning equipment.

Some or all of the Hydrolab instantaneous DO data was rejected for the following dates (although Winkler values were recorded):

- July 22-24, 2002
- September 23-25, 2002
- October 21-22, 2002
- November 12, 2002
- January 7, 2003
- April 8, 2003

In addition, for the following Year 1 sampling dates, some or all of the instantaneous DO results were corrected but qualified as an estimates (denoted with “J”) due to poor correlation between Hydrolab and Winkler values:

- July 9, 2002
- August 6, 2002
- August 27, 2002
- October 9, 2002
- November 12, 2002

#### *Year 2 Instantaneous DO Bias*

The average adjustment for Year 2 instantaneous DO data was -0.12 mg/L (pooled standard deviation of 0.51 mg/L) with a pooled %RSD of 3.9%, well below the target maximum bias of 5%. For several Year 2 sampling dates, instantaneous DO results were rejected or qualified due to poor correlation between Hydrolab and Winkler values, or malfunctioning equipment.

All of the Hydrolab instantaneous DO data was rejected for the following dates (although Winkler values were recorded):

- August 25-27, 2003

In addition, for the following Year 2 sampling dates, some or all of the instantaneous DO results were corrected but qualified as an estimates (denoted with “J”) due to poor correlation between Hydrolab and Winkler values:

- July 8-9, 2003
- August 20, 2003
- September 8, 2003
- September 22 and 24, 2003
- Sept 29-30, 2003
- October 1, 2003
- October 6, 2003
- October 20-21, 2003

Other than the noted exceptions, all other DO data were considered acceptable for use although data are considered provisional until publication of the final report. Data variability will be taken into consideration in using the data for modeling and other analysis, and interpreting results.

## Continuous Measurement Bias

The average difference of post-calibration pH readings for continuous Hydrolab® meters was 0.08 s.u. (standard deviation of 0.10 s.u.). The pooled bias for all of the post-calibration continuous pH readings was 0.09 s.u. (the target maximum bias was 0.1 s.u.). All continuous pH readings were considered acceptable except pH readings from Hydrolab® meter #21 used on April 7-10, 2003 which were qualified because of poor post-calibration.

Post-calibration checks for continuous conductivity measurements had a pooled %RSD bias of 5%, meeting the target maximum bias of 5%. All conductivity measurements were considered acceptable for use without qualification.

To date, QA of the continuous DO data is incomplete for the 59 continuous data profiles recorded with Hydrolab® meters for the project. A preliminary QA/QC check has been done on continuous DO profiles from the Class AA reaches and several in the lower Wenatchee River and Icicle Creek (presented below); however, all continuous DO data is considered provisional and in draft form until QA analysis and modeling is complete and the final report is published.

## Accuracy

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For field measurements, target objectives for accuracy were set for velocity and temperature. Both accuracy targets are from manufacturers specifications for the respective instruments (velocity meter and thermometer). Instruments are factory calibrated and were considered to be performing within the specified published accuracies during the field season.

## Conclusion

The QA and QC of the data reviewed so far suggest that the Ecology data are of good quality and are properly qualified.

# Preliminary Data Results and Discussion

## Wenatchee River TMDL Data

All laboratory and field data collected for the Year 1 and Year 2 (to date) Wenatchee River TMDL are loaded into Ecology's Environmental Information Management (EIM) database and are available on-line from the Ecology web-site at: <http://www.ecy.wa.gov/programs/eap/env-info.html>. Several query options are available. The study identification (study id) designation is "WENRTMDL" and the study name is "Wenatchee River TMDL".

Additional data collected by Ecology's Freshwater Monitoring Unit (FMU) is used in this TMDL analysis and is also available on-line at the above EIM web-site. The study identification (study id) designation for this data is AMS001. Table 17 shows the FMU stations used in support of the Wenatchee River TMDL effort.

Table 17. Ecology's Freshwater Monitoring Unit stations used in the Wenatchee TMDL study and the project station equivalent.

FMU Station	Wenatchee TMDL Project station equivalent	Site Description
45D070	45BR00.4	Brender Creek above mouth
45C070	45CS00.5	Chumstick Creek near mouth
45C060	45CS00.1	Chumstick Creek above mouth
45Q060	45EG00.3	Eagle Creek above mouth
45E070	45MC00.2	Mission Creek near Cashmere
45R050	45NN00.2	No Name Creek at Mill Rd
45A070	45WR00.5	Wenatchee River near mouth
45A110	45WR35.4	Wenatchee River near Leavenworth (Tumwater canyon Hwy 2 bridge)

## Year 1 Wenatchee River and Icicle Creek Data Results

The major parameters of concern for the Wenatchee River and Icicle Creek are pH and DO because parts of both waterbodies are currently 303(d)-listed for these parameters. In addition, phosphorus and nitrogen are important parameters because of their role as nutrients for the growth of periphyton in the waterways. Periphyton (attached algae) plays an important role in the dynamics of pH and DO processes in the Wenatchee River and Icicle Creek.

Ecology defines the critical low-flow river condition for TMDLs to be the 7-day-average low-flow with a reoccurrence interval of once every 10 years on the average (7Q10) (i.e., a 10<sup>th</sup> percentile flow). The seasonal (July through October) 7Q10 for the Wenatchee River is 344 cfs (based on the 1962 to present USGS record at Monitor). The 2002 seasonal 7-day low-flow was

406 cfs (or approximately a 20<sup>th</sup> percentile flow). This means that water quality standard exceedances observed in 2002 might be exacerbated in a critical year with 7Q10 conditions.

The following is a brief review of the data results for these parameters, including a summary of observed water quality standard exceedances during 2002-03. The water quality of the Wenatchee River, Icicle Creek, and tributaries will be discussed in more detail in the final project report in 2005.

## Dissolved Oxygen and pH

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### **Class AA reaches**

Continuous and grab sample data show that DO concentrations in the Wenatchee River and Icicle Creek were sometimes below the DO criterion of 9.5 mg/L in their respective Class AA water segments. The Class AA waters begin at the first junction with the Wenatchee National Forest boundary. The first Wenatchee National Forest boundaries occur just upstream of Leavenworth within Tumwater canyon on the Wenatchee River and just upstream of the Leavenworth National Fish Hatchery on Icicle Creek. It should be noted that private land ownership is interspersed with public ownership above these Class AA boundaries.

Nine out of 25 data-logger profiles from eight Class AA reaches of the Wenatchee River, Icicle Creek, or their tributaries showed DO concentrations less than the 9.5 mg/L criterion. Eight of the nine profiles were from the late August survey when the diel water temperature change was approximately 3-4 degrees C; the other was from the September survey. Figure 9 is an example of the data logger continuous data from one site. The diurnal changes in DO concentrations at all eight reaches were almost completely due to the diurnal changes in water temperature which affected the DO solubility in water (i.e., temperature is the main pollutant causing the DO to be in exceedance). When water temperatures dropped, the DO solubility increased and DO diffused into the water through reaeration. When the water temperature rose, the DO solubility decreased and DO diffused to the atmosphere.

Whiley and Cleland (2003) used effective shade as a surrogate for thermal load in developing a temperature TMDL for the Wenatchee National Forest. They found that the site-potential effective shade (in the Class AA reaches which were monitored with data-loggers for this study) was not sufficient to meet the numeric Class AA water temperature criterion of 16° C, implying that natural conditions may exceed the numeric criterion (in which case the natural condition becomes the criterion). It should be noted that even when the water temperatures met the Class AA criterion of 16° C, DO concentrations of less than 9.5 mg/L were observed (based on the August 2002 data-logger profiles). In these Class AA reaches, natural DO concentrations will likely be below 9.5 mg/L during the summer months. Implementation of the Wenatchee National Forest temperature TMDL and the upcoming Wenatchee River temperature TMDL will improve temperature (and therefore DO) as much as possible; however, in addition, current and future BOD and nutrient loading should be restricted in the Class AA waters to keep from further reducing DO concentrations in these reaches (i.e., there should be no additional BOD loading to reduce the DO below natural DO concentrations).

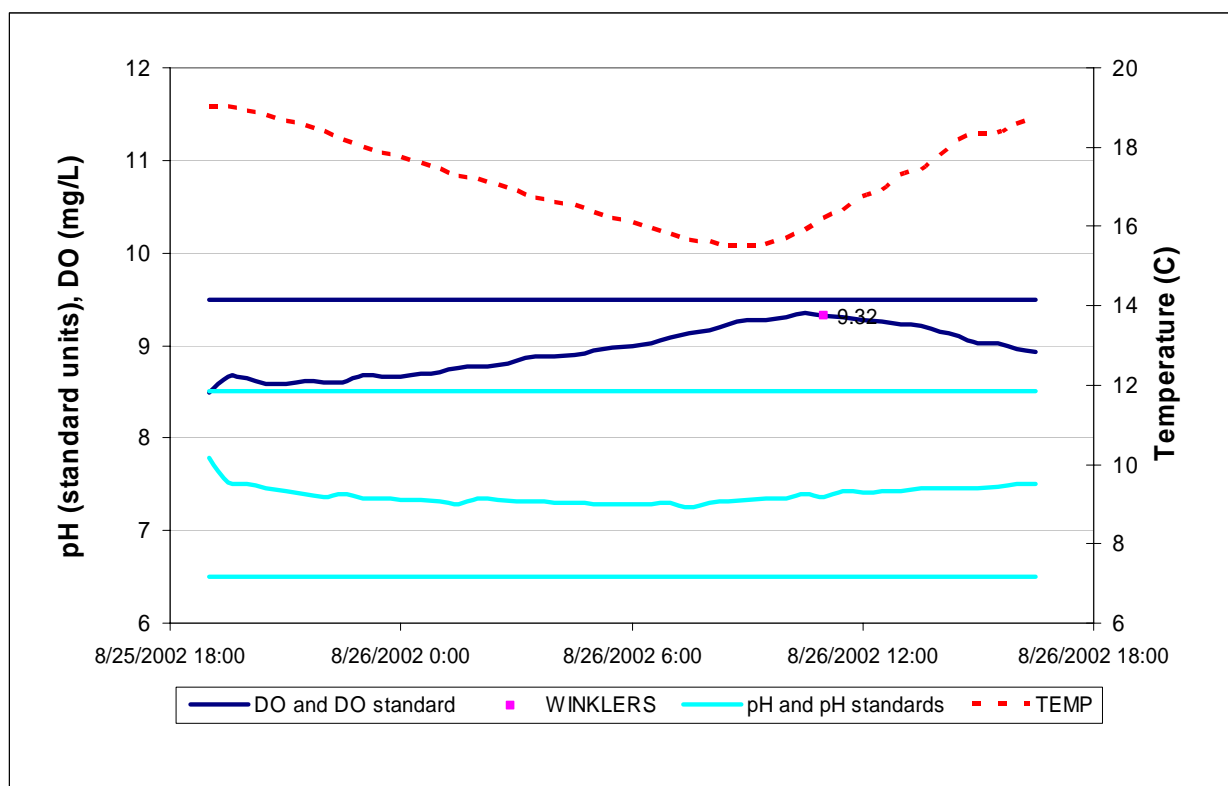


Figure 9. Diurnal data collected with a data logger in the Wenatchee River at the Tumwater Canyon Highway 2 bridge (station 45WR35.4) on August 25-26, 2002.

In addition to the data-logger profiles, Table 18 presents the 16 grab sample (instantaneous) DO readings that show values below the Class AA numeric criterion in the Wenatchee River, Icicle Creek, or immediate tributaries to the Class AA reaches. Sites 45BC00.1 and 45WDB included irrigation spill-water from the Chiwawa Irrigation District. Two sites, both outlets of the Wenatchee River headwater lakes (Lake Wenatchee and Fish Lake), had DO concentrations <8.0 mg/L. With the exception of the lake outlet readings, the exceedances are most likely from warmer water temperatures resulting in low DO solubility as seen in the data logger profiles above. The reason for the low DO from the lake outlets is not understood at this time.

All pH measurements from instantaneous measurements and data-loggers fell within the water quality standard of 6.5 to 8.5 pH units within the Class AA reaches.



Table 18. Instantaneous (grab sample) DO exceedances (<9.5 mg/L) in the Class AA reaches of the Wenatchee River, Icicle Creek, and their tributaries.

Station	Date	DO (mg/L)	Qualifier
45BC00.1	7/22/2002	9.36	
45FL00.3	6/25/2002	7.75	
45FL00.3	7/22/2002	6.31	
45IC03.0	8/27/2002	9.35	
45JC00.1	9/24/2002	9.46	J
45LR01.2	8/26/2002	8.94	
45SC00.1	7/23/2002	8.91	
45WDB	8/26/2002	9.28	
45WR30.7	9/23/2002	9.25	J
45WR30.7	10/22/2002	9.35	
45WR35.4	8/26/2002	9.32	
45WR41.8	7/22/2002	9.44	
45WR41.8	8/26/2002	9.15	
45WR46.2	8/26/2002	9.3	
45WR54.0	8/26/2002	8.81	
45WR54.0	12/3/2002	6.33	

### **Class A reaches**

In the Class A reaches of the Wenatchee River and Icicle Creek, there were DO and pH exceedances observed in the continuous and grab sample data. In these reaches, the diurnal changes in the continuous DO and pH data were primarily due to the photosynthesis and respiration of periphyton (attached algae). Periphyton respiration and photosynthesis can cause large diurnal (day-night) fluctuation in DO and pH (Wetzel, 1983; Welch, 1992). Photosynthesis dominates during daylight hours and respiration dominates at night. DO is generated during photosynthesis, producing maximum DO concentrations in the afternoon. Respiration by periphyton and bacteria consumes DO, causing early morning minima of DO. In addition, photosynthesis and respiration affect pH throughout the day. Periphyton consume carbon dioxide during photosynthesis, altering the carbonate system which controls pH, leading to maximum pH values in the afternoon. Overnight respiration produces carbon dioxide causing minimum early morning pH values. Figure 10 presents a data logger profile from station 45WR01.0, Wenatchee River above the mouth, showing the diurnal changes in DO and pH on August 28-30, 2002.

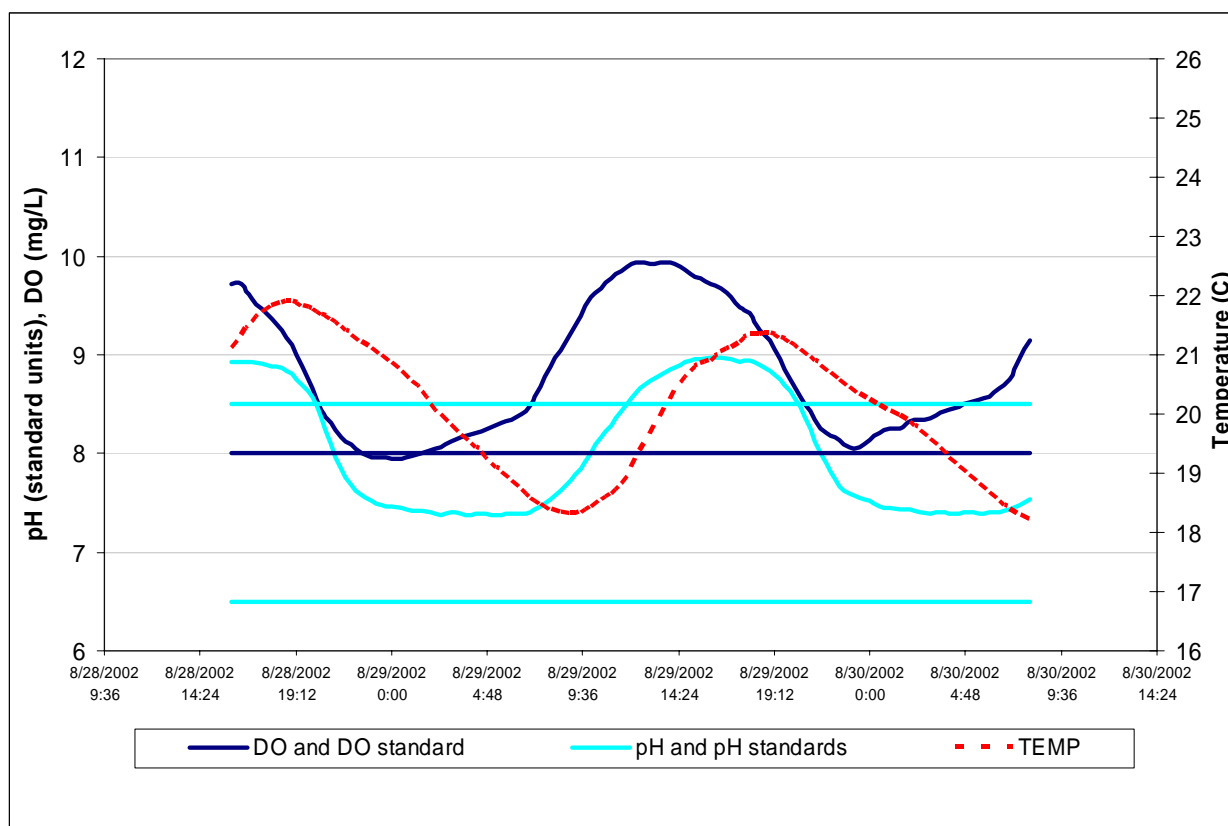


Figure 10. Diurnal data collected with a data logger 1.0 mile upstream from the mouth of the Wenatchee River (station 45WR01.0) on August 28-30, 2002.

Table 19 contains a summary of the stations in the Class A waters with observed exceedances based on the data logger profiles (blank boxes indicate that no profile was taken). On Icicle Creek, only the mouth (45IC00.1) showed DO and pH exceedances in the data logger profiles. On the Wenatchee River, all the DO and pH exceedances occurred at stations between the Highline Diversion (mile point 17.2) and the mouth. Similarly, all instantaneous (grab sample) pH readings in exceedance of pH standards (Table 20) occurred in the same lower Wenatchee River reach, with the exception of one reading above Peshastin (45WR21.0).

Data logger profiles showing DO exceedances only occurred in the July and August surveys, probably due to the warmer water temperatures (less DO solubility) during those months. Otherwise sufficient reaeration seems to prevail (except at the mouth; see below). Data logger profiles showing pH exceedances occurred in the August, September, October, January, and April surveys indicating that the onset of sufficient periphyton productivity (i.e., enough to cause pH exceedances) occurred in August and continued through the winter despite very low water temperatures in the winter (growth rates for periphyton are temperature dependent).

In addition, there seems to be a deleterious DO condition at the confluence of the Wenatchee River with the Columbia River. While the 2002 data collection generally did not show DO exceedances in the lower Wenatchee mainstem (again, probably due to sufficient reaeration),

there appears to be a low DO condition at the mouth of the Wenatchee River. The mouth appears to be the most water-quality limited reach in the Wenatchee River.

A data logger deployment on August 28, 2002 shows DO levels dropping to below 6 mg/L (Figure 11). Oscillations (upstream and downstream movement of water) were visible on this date and are indicated in the DO profile as up and down spikes. In addition, the high pH exceedances seen in the rest of the lower Wenatchee are also visible at this site. Depending on the level of the Columbia River (perhaps from daily adjustment at Rock Island Dam for power generation or from upstream surges), there can be a pooling effect and back-up of Columbia River and Wenatchee River water at the mouth during summer low-flow (and perhaps at other times). How DO and pH are influenced by the pooling effect is unknown at present. There is a dominating diurnal effect due to algal photosynthesis and respiration, but the low DO may be exacerbated by oxidation of organic matter interned in the mouth, and/or reduced reaeration due to the rising water of the Columbia River. The deleterious DO effects seen in 2002 could be worse during 7Q10 critical flow conditions. These hypotheses will be explored in water quality modeling exercises for the final project report in 2005.

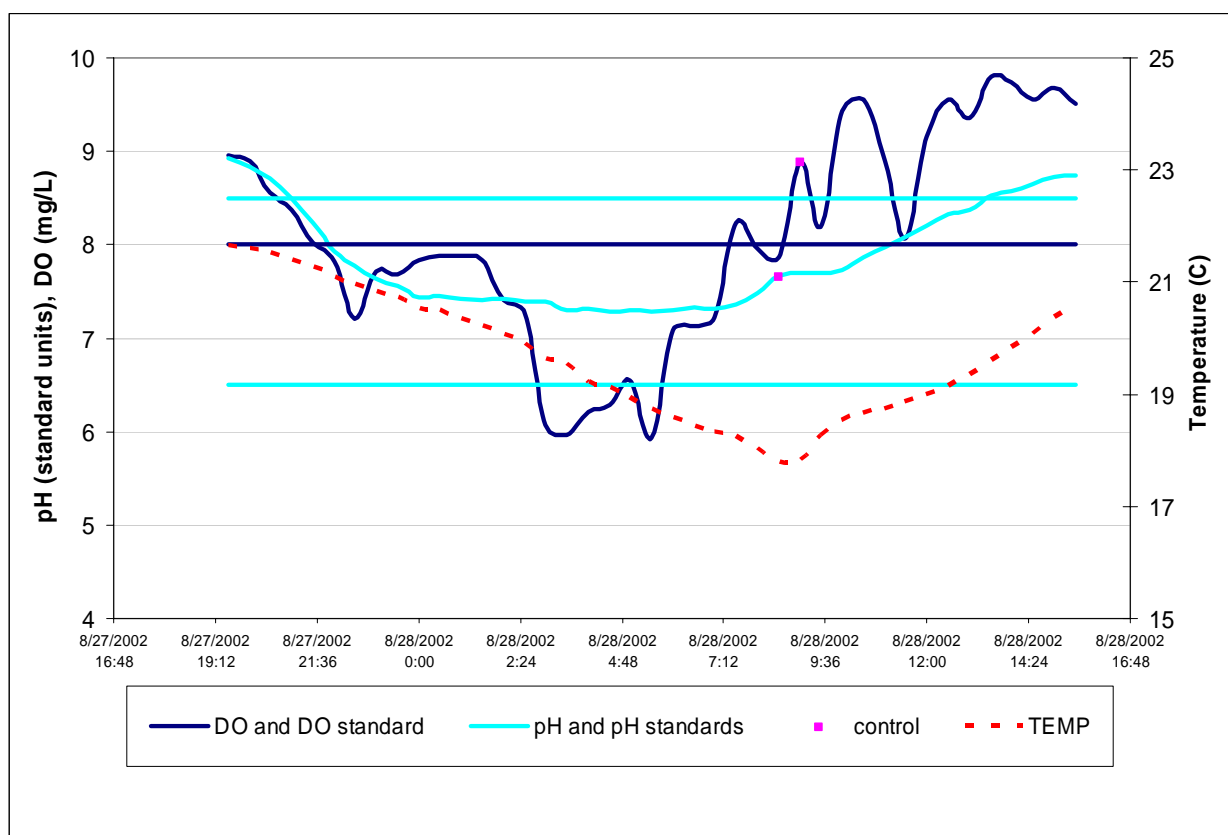


Figure 11. Diurnal data collected with a data logger at the mouth of the Wenatchee River (station 45WR00.5) on August 27-28, 2002.

Table 19. Summary of stations showing DO and/or pH water quality standard exceedances in data logger profiles. “Yes” indicates an exceedance, “No” indicates no exceedance, and blanks indicate that a profile was not taken at the station for that month.

	July-02		August-02		September-02		October-02		Jan/April-03	
Station	DO	pH	DO	pH	DO	pH	DO	pH	DO	pH
45WR17.2	Yes	No	No	Yes	No	Yes				
45WR14.1	No	No	No	Yes						
45WR10.8			No	Yes	No	Yes				
45WR06.5			Yes	Yes	No	Yes			No	Yes
45WR01.0			Yes	Yes	No	Yes	No	Yes	No	Yes
45WR00.5	Yes	No	Yes	Yes						
45IC00.1	No	No	Yes	Yes	No	Yes	No	No	No	No

Table 20. Instantaneous (grab sample) pH exceedances (>8.5pH) in the Class A waters of the Wenatchee River.

Year 1			
Station	Date	pH	Qualifier
45HR00.1	10/9/2002	10	
45MC00.2	10/7/2002	8.7	
45WR00.5	10/7/2002	9	
45WR00.5	4/7/2003	8.6	
45WR01.0	4/9/2003	8.6	
45WR02.8	9/25/2002	8.6	
45WR06.5	1/7/2002	8.7	J
45WR06.5	9/25/2002	8.8	
45WR06.5	10/9/2002	9.1	
45WR06.5	11/13/2002	9.1	
45WR06.5	12/3/2002	8.7	
45WR06.5	4/9/2003	8.6	
45WR10.8	10/22/2002	8.7	
45WR10.8	4/9/2003	8.6	
45WR14.1	10/9/2002	8.6	
45WR14.1	11/13/2002	8.6	
45WR17.2	8/28/2002	8.7	
45WR17.2	10/22/2002	8.8	
45WR21.0	10/22/2002	8.6	

## Phosphorus

Nutrients are necessary for the growth of periphyton and phosphorus is often the most limiting nutrient for algal growth in natural freshwater (Wetzel, 1983). This is particularly true if the dissolved inorganic nitrogen to ortho-phosphate ratios (N:P ratio) are  $>7$  (Reynolds, 1984). Figure 12 presents the N:P ratios (dissolved inorganic fractions) for the Wenatchee River by monthly survey. In general, the N:P ratio is above 7 in the river at all times, indicating phosphorus limitation. The exception was above RM 17 during the growing season (July through October) when the N:P ratios were below 7 and nitrogen may have been limiting. However, the nitrate and/or ortho-phosphate concentrations above RM 17 during the growing season were at or below detection limits (10 mg/L and 3 mg/L, respectively) so the true N:P ratios are unknown. In general, there was limited productivity in these upper reaches due to the general lack of both nitrogen and phosphorus.

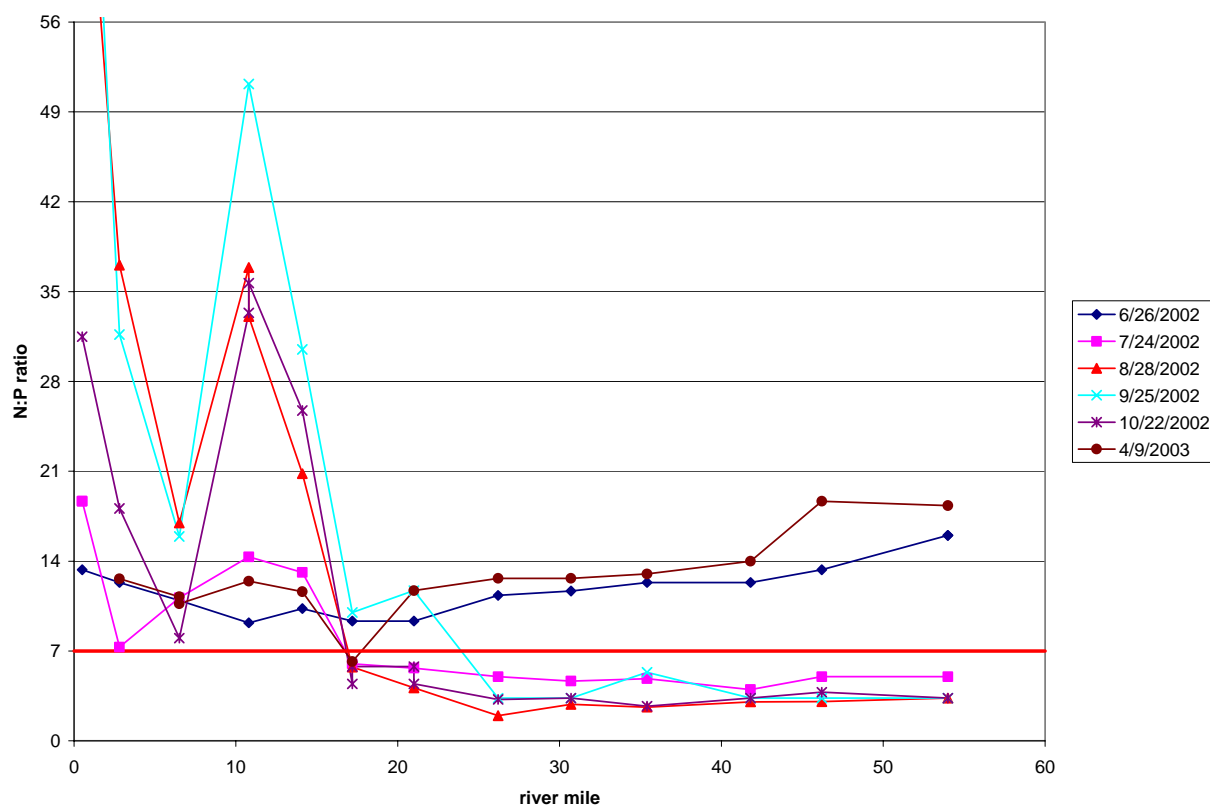


Figure 12. N:P ratios (dissolved inorganic nitrogen to ortho-phosphate ratio) for the Wenatchee River by river mile for each monthly survey.

Figure 13 shows the ortho-phosphate concentrations for the monthly surveys by river mile, from Lake Wenatchee (RM 54.0) to just above the mouth (RM 0.5). The graph shows that ortho-phosphate concentrations were very low (less than 4 ug/L) from Lake Wenatchee to below the City of Leavenworth, then increased moving downstream from Leavenworth, particularly in the months of September and October when flows were lowest in the river (i.e., when there is less

dilution). While the ortho-phosphate concentration levels are relatively low (e.g., <20 ug/L P) compared to other streams in Washington State, this increase in bio-available phosphorus in the lower reach of the Wenatchee River (i.e., below Leavenworth) most likely fuels the increase in periphyton biomass resulting in the observed pH and DO exceedances found in the lower Wenatchee River reaches. Implementing control measures for phosphorus from point and non-point sources will likely mitigate the DO and pH water quality exceedances in the lower Wenatchee River reaches.

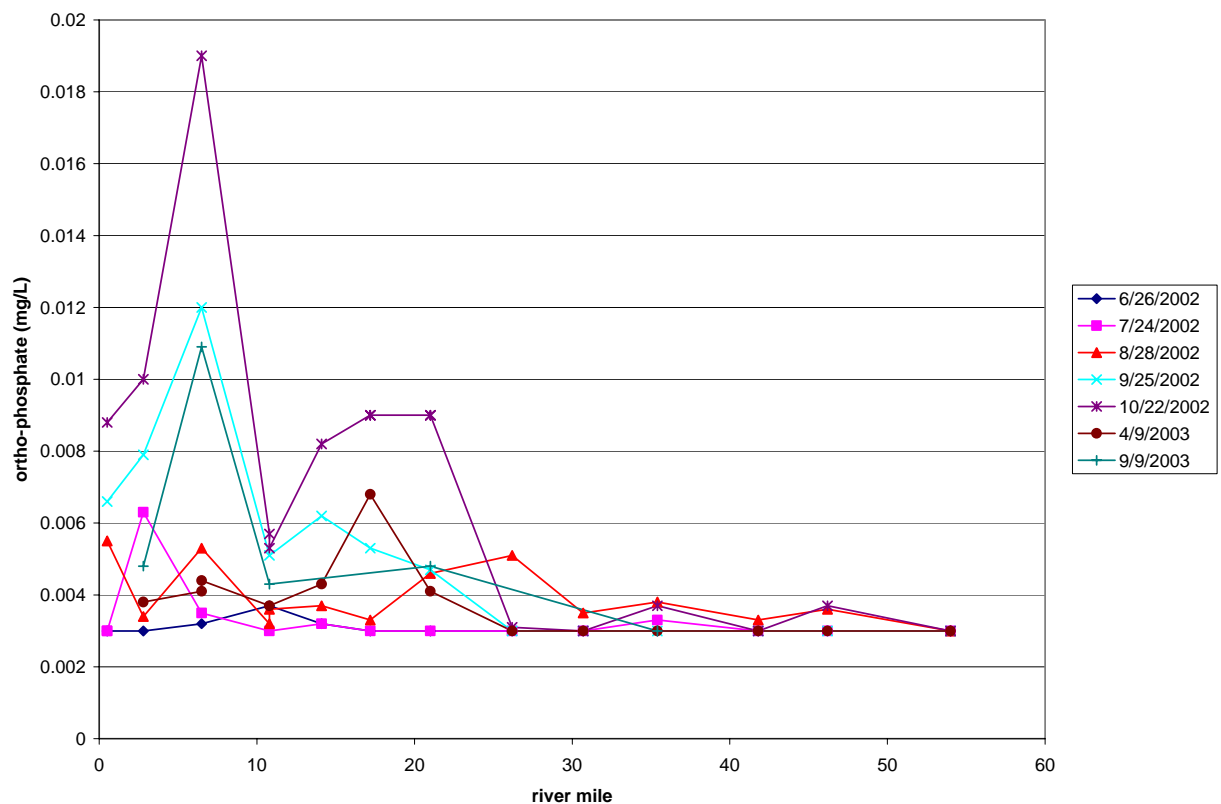


Figure 13. Ortho-phosphate concentrations for the monthly surveys by river mile, from Lake Wenatchee (RM 54.0) to just above the mouth (RM 0.5). Reporting limit for ortho-phosphate is 0.003 mg/L.

## Sources of Oxygen-Consuming Substances and Phosphorus

Five facilities have National Pollutant Discharge Elimination System (NPDES) permits for discharging biochemical oxygen demand and/or ammonia to either Icicle Creek or the Wenatchee River. The effluents from the following facilities were sampled for this TMDL effort:

Icicle Creek:

- City of Leavenworth Water Treatment Plant (WTP)

Wenatchee River:

- Lake Wenatchee Publicly-Owned Treatment Works (POTW); (influent station name: LAKEWNI; effluent station name: LAKEWNE)
- City of Leavenworth POTW; (station name: LEAVWWTP)
- City of Peshastin POTW; (station name: PESHTN)
- City of Cashmere POTW; (station name: CASHMR)

Appendix A contains a summary of the permit limits for these facilities as well as a synopsis of field notes taken during the sampling efforts.

The following fish hatcheries have an NPDES General Upland Fin-Fish Hatching and Rearing Discharge Permit for Icicle Creek, Wenatchee River, and/or the Chiwawa River:

- Leavenworth National Fish Hatchery; (station names: 45LNFHA (abatement pond); 45LNFHD (return Ditch); 45LNFHO (main outlet); and 45LNFHS (below spillway))
- Chiwawa Ponds Hatchery; (station name: 45CW00.5)
- Dryden Ponds Hatchery; (station name: 45WR15.6)

Irrigation water purveyors have recently been required by law to obtain an NPDES permit for discharge back to natural waterways if applying aquatic herbicides in their water canals or ditches. Aquatic weeds and periphyton within the irrigation canals as well as non-point sources to irrigation canals may contribute BOD and phosphorus loads to the Wenatchee system. The following irrigation water districts or purveyors divert and discharge to water within the Wenatchee River basin:

- Icicle and Peshastin Creek Irrigation District
- Cascade Orchards Irrigation District
- Chiwawa Irrigation District
- Wenatchee Reclamation District
- Jones Shotwell Irrigation District
- Gunn Ditch Irrigation District

The following tributaries affect DO levels and nutrient concentrations in the Wenatchee River during the summer low-flow period:

- Nason Creek. The Stevens Pass Sewer District has a small Class IV Advanced Wastewater Treatment plant (tertiary treatment with alum addition) that services the ski resort area and has an NPDES permit to discharge to Nason Creek.
- Chiwawa River. This river drains primarily Forest Service lands, though a community of private residences with on-site septic systems is established near the mouth of the river.
- Chiwaukum Creek. This creek drains primarily Forest Service lands though a wastewater lagoon drains to groundwater near the mouth.
- Icicle Creek. This creek drains primarily Forest Service land but has multiple potential point and non-point source impacts from fish aquaculture, agriculture, and urban sources.

- Chumstick Creek. This creek drains primarily Forest Service lands but has multiple potential non-point source impacts from both agricultural and urban sources.
- Peshastin Creek. This creek drains primarily Forest Service lands.
- Mission Creek. This creek drains primarily Forest Service lands but has multiple potential non-point source impacts from both agricultural and urban sources.

Groundwater discharging to the Wenatchee River, Icicle Creek, and their tributaries also affect DO levels and nutrient concentrations. Groundwater discharges to the river or creeks in some reaches, and is recharged in other reaches. In the Wenatchee basin, background groundwater flow and BOD/nutrient concentrations may be elevated due to upland practices such as orchard irrigation and wastewater discharge to groundwater from on-site septic systems.

In addition, non-point sources along the length of the river may be contributing BOD and nutrients. There may be high-concentration non-point source areas associated with large community on-site septic systems, a high density of individual on-site septic systems, or failing public wastewater collection or treatment systems. Most notable examples of such possible sources are the City of Dryden POTW that discharges wastewater to a large community drainfield alongside the Wenatchee River, and the City of Cashmere POTW sewage lagoons which have been confirmed to be leaking alongside the Wenatchee River.

Other than the tributary, groundwater, and non-point loads described above, other nonpoint sources along the mainstem of the river are probably relatively insignificant for this project because stormwater and combined sewer overflow discharge to the river does not occur during the period of concern. The contributions of BOD and nutrients from small discharges to the tributaries of the Wenatchee River and Icicle Creek were included as part of the tributary loading to the river, and not assessed as “discrete” loads for this study.



## Year 2 Wenatchee Tributary Data Results

Year 2 (2003) sample collection focused on the tributaries to the Wenatchee River that were listed on the 303(d) list for FC bacteria, as well as other conventional parameters. FC bacteria data during the low-flow irrigation season (July through October) confirmed the 303(d) listings for fecal coliform bacteria (FC) in Mission, Brender, and Chumstick creeks. In addition, exceedances were observed in the following tributary creeks: No Name, Yaksum, Little Chumstick, Eagle, and Van creeks. Tables 21 through 23 give FC summary statistics for all sampling sites by watersheds. Exceedance of the standard (highlighted and bolded) occurred if either the geometric mean concentration exceeded 100 cfu/100mL or the 90<sup>th</sup> percentile concentration exceeded 200 cfu/100mL (90<sup>th</sup> percentiles based on using Z-statistic of 1.2816 and log-normal distribution statistics).

In general, the upper-most reaches of these smaller tributaries, most of which originate from National Forest boundaries, met the FC water quality standards (the exception being the upper Chumstick Creek site, 45CS11.3). Moving downstream in all the tributaries, FC concentrations increased and exceedances began to occur. While the number of stations with exceedances may create a sense that all of the lower reaches of these watersheds are contaminated, it should be noted that during a mass balance evaluation (see below) certain reaches were found to be contributing larger loads than others thus contributing to exceedances at downstream stations (i.e., the bacteria move downstream with the streamflow).

Table 21. Summary statistics for Year 2 FC sampling in the **Mission Creek** basin. Exceedances of water quality standard are highlighted and bolded.

Station	# of observations over 200 cfu/100mL	# of days station was sampled	Geometric mean of daily samples (cfu/100mL)	90 <sup>th</sup> percentile of daily samples (cfu/100mL)
MC00.2	10	23	91	<b>1799</b>
MC00.4	1	3	<b>204</b>	<b>679</b>
PRM00.1	4	9	<b>133</b>	<b>2097</b>
MC00.6P	1	4	47	<b>544</b>
MC00.6	6	8	<b>842</b>	<b>5746</b>
MC00.9	6	10	<b>384</b>	<b>8180</b>
MC01.2	7	10	<b>221</b>	<b>693</b>
YC00.3	3	10	77	<b>519</b>
YCALT	1	3	<b>107</b>	<b>910</b>
ISR00.1	2	4	<b>205</b>	<b>801</b>
MC01.7	1	4	63	<b>206</b>
MC02.3	3	4	<b>174</b>	<b>1017</b>
MC03.0P	3	5	<b>208</b>	<b>1600</b>
MC03.0	3	7	<b>107</b>	<b>952</b>
MC03.8	2	3	<b>326</b>	<b>1111</b>
MC04.4	1	9	83	<b>256</b>
MC05.1	1	5	76	<b>338</b>
MC07.2	0	9	27	90

SN00.1	0	5	34	106
MC08.6	0	5	12	31

Table 22. Summary statistics for Year 2 FC sampling in the **Brender Creek** basin.  
Exceedances of water quality standard are highlighted and bolded.

Station	# of observations over 200 cfu/100mL	# of days station was sampled	Geometric mean of daily samples (cfu/100mL)	90 <sup>th</sup> percentile of daily samples (cfu/100mL)
BR00.4	6	10	<b>231</b>	<b>632</b>
BR00.7	10	10	<b>521</b>	<b>1394</b>
PS00.1	0	6	30	191
BR01.2	8	10	<b>454</b>	<b>1794</b>
BR01.4	5	8	<b>263</b>	<b>1166</b>
BR01.6	7	10	<b>453</b>	<b>2237</b>
BR01.9	3	4	<b>396</b>	<b>3147</b>
BR02.0	2	3	<b>309</b>	<b>2469</b>
BR02.1	2	2	<b>627</b>	<b>867</b>
BR02.5	2	10	<b>120</b>	<b>502</b>
PR00.1A&B	0	6	46	63
BR03.0	1	4	37	197
ID00.1	0	7	9	25
BR03.4	1	5	38	166
BR04.1	1	10	39	167
NN00.1	3	9	27	<b>413</b>
45R050	10	12	<b>497</b>	<b>1479</b>
NN00.2	8	9	<b>402</b>	<b>799</b>
NN00.3	2	2	<b>765</b>	<b>2593</b>
NN00.4	1	2	<b>141</b>	<b>429</b>
NN00.5	1	9	93	<b>242</b>
NN01.1 & 1.3	0	9	42	148

Table 23. Summary statistics for Year 2 FC sampling in the **Chumstick Creek** basin. Exceedances of water quality standard are highlighted and bolded.

Station	# of observations over 200 cfu/100mL	# of days station was sampled	Geometric mean of daily samples (cfu/100mL)	90 <sup>th</sup> percentile of daily samples (cfu/100mL)
CR00.1	0	10	30	94
FX00.1	2	10	14	156
CS00.1	2	10	95	<b>391</b>
CS02.0	1	4	<b>110</b>	<b>596</b>
CS03.8	3	10	<b>106</b>	<b>368</b>
CS04.3	1	2	66	<b>517</b>
CS04.9	5	10	<b>138</b>	<b>684</b>
CS06.8	0	3	73	135
CS07.7	5	10	<b>339</b>	<b>2449</b>
CS08.3	2	5	<b>121</b>	<b>315</b>
CS08.6	2	5	<b>127</b>	<b>525</b>
CS09.1	0	10	66	179
CS11.3	1	4	<b>119</b>	<b>322</b>
LC00.1	1	5	63	<b>366</b>
EG00.3	1	1	<b>235</b>	NA
EG00.9	2	8	85	<b>378</b>
EG05.8	0	10	54	115
VC00.1	5	10	<b>190</b>	<b>781</b>
VC00.5	0	4	49	117

Simple mass-balance reach-load analyses were completed for FC loads in Brender, No Name, Mission, and Chumstick creeks, treating FC as conservative (i.e., no losses from die-off or settling plus no gain from re-suspension) and averaging by station for stations that were sampled on the same dates (n = 9 or 10).

Figure 14 shows the net and cumulative FC loads observed in Brender Creek. Nearly 85% of the net FC load entered between RM 1.2 and 2.5. The reach from RM 1.2 to RM 1.6 is a reach of moderate groundwater inflow with observed saturated soils and seepage along the stream banks. There was no FC in groundwater samples taken from piezometers in this reach (Sinclair, 2003; unpublished data); however, domestic on-site septic systems in this reach (RM1.2 to RM 1.6) should be checked for proper functioning in the saturated soils. The reach from RM1.6 to RM 2.5 is generally orchard land with about a dozen houses along the creek corridor. A walking inspection of the creek is recommended in this reach to look for illegal discharges and all of the domestic on-site septic systems should be evaluated for proper functioning.

There was no net FC loading from RM 1.2 to 0.4. The cumulative load loss in this reach could be explained by FC die-off or settling within the reach. Sampled irrigation spill returns to

Brender Creek from the Icicle and Peshastin Irrigation District's canals generally had FC concentrations well below FC standards.

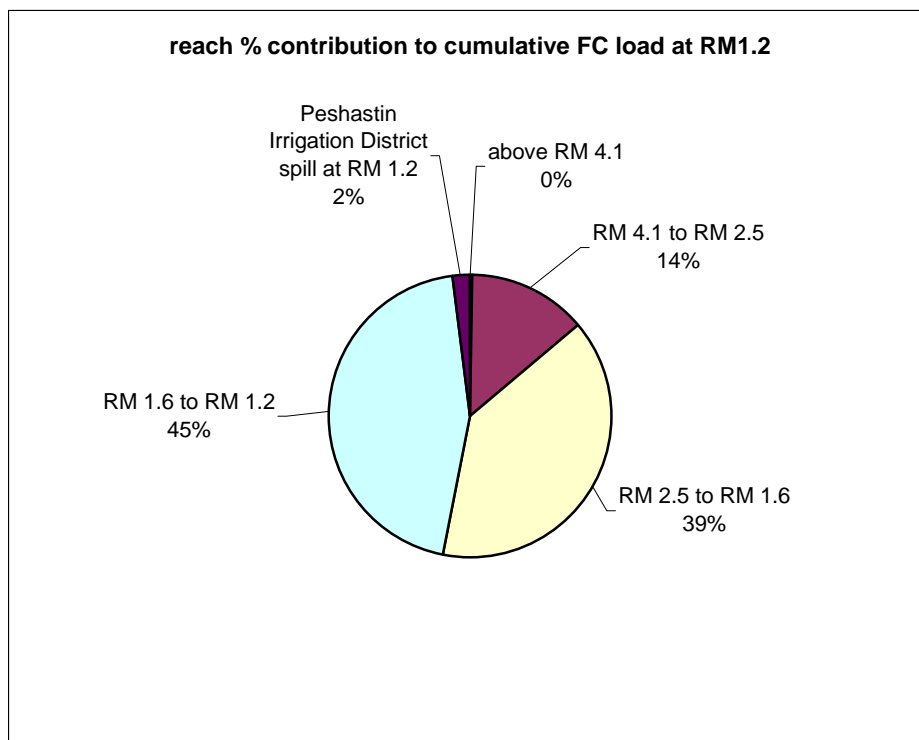
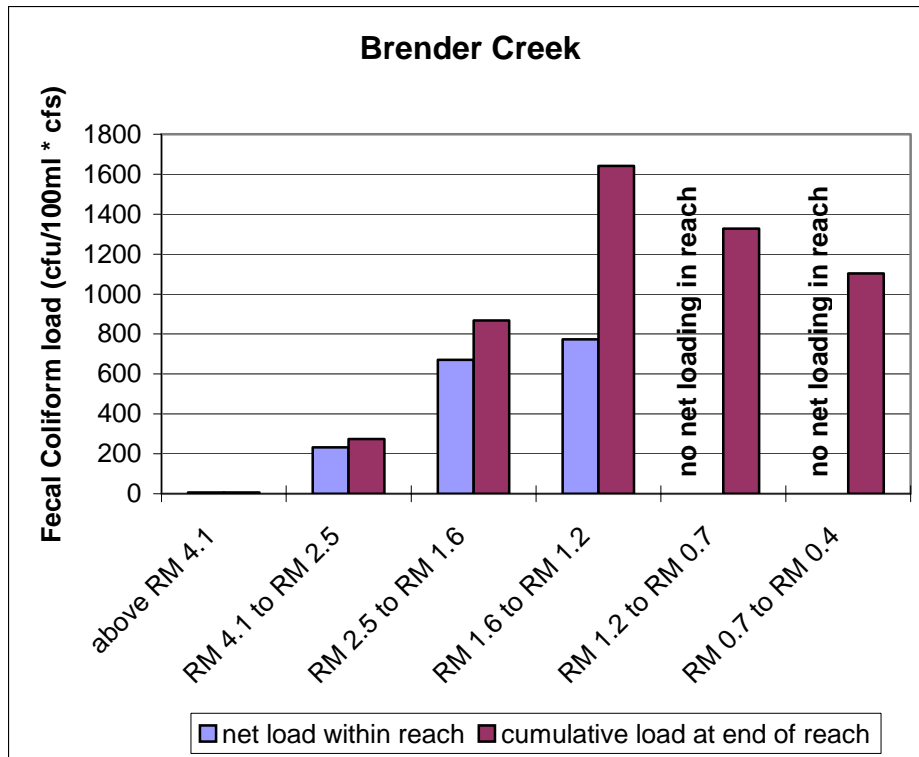


Figure 14. Net and cumulative FC loads in Brender Creek with reach % contribution (for the period July through October 2003; n=10).

Figure 15 shows the net and cumulative FC loads observed in No Name Creek. No Name Creek had approximately a quarter of the FC cumulative load that Brender Creek had. Nearly 90% of the net FC load for No Name Creek entered between RM 0.5 and 0.2. This reach contains a ponded area of the creek used by ducks. There were generally 5-6 ducks counted during late-summer surveys. Using manure production and characteristics for ducks published by ASAE (1999), the 5-6 ducks using the pond could potentially account for a majority of the FC load in No Name Creek at such low flow (e.g., mean flow for the 2003 surveys was 0.8 cfs below the pond). There was no net loading in the lowest reach from RM 0.5 to 0.2. The cumulative load loss in this reach could be explained by FC die-off or settling within the reach. Apparently, the No Name Creek drainage has been filled in from Sunset Highway to near the mouth (recent fill and grading work is evident), though there appears to be a buried culvert.

Figure 16 shows the net and cumulative FC loads observed in upper Chumstick Creek. Cumulative FC loads in Chumstick Creek were slightly lower than those in No Name Creek. Stream flow in Chumstick Creek was discontinuous below RM 3.8 (i.e., the creek went dry) so only the upper portion of the creek (above RM 3.8) was shown in the figure. Nearly 50% of the net FC load entered upper Chumstick Creek between RM 9.1 and 7.7. This stretch of the creek is characterized as having primarily rural land-use with agriculture, on-site septic systems, and wildlife potentially contributing as non-point sources.

Flow returned at the mouth of Chumstick Creek, primarily from nearby irrigation spill returns, but also from upstream groundwater seepage. Generally, the irrigation spill returns had very low FC concentrations so the FC load at the mouth can be attributed to land-use and non-point sources in the reach above the mouth. In addition, Van Creek and Eagle Creek (also in the Chumstick watershed) were found to meet FC standards at their Forest Service boundaries, but not below.

Figure 17 shows flows in Mission Creek for the 2003 sampling dates. Flows decreased in Mission Creek from the Forest Service boundary to RM 3.0, presumably due to diversion for irrigation. Mission Creek was dry at RM 3.0 and RM 2.3 for most of the sampling season, but downstream a small amount of flow (usually less than 1 cfs) returned by RM 1.2, apparently groundwater seepage return or spill from irrigation ditches. It was difficult to characterize net or cumulative FC load gains or losses in Mission Creek because the loads were not transferred in the dry stretches. Figure 18 shows all the FC sample concentrations taken in Mission Creek for the 2003 surveys. Concentrations increased greatly (notice log scale) between RM 1.2 and RM 0.9. There was also a jump in concentration at stations RM 5.1, 3.8, and 1.2. All of the reaches above these stations should be checked for potential non-point FC load contributors.

Mission Creek has primarily rural land-use with agriculture, on-site septic systems, and wildlife potentially contributing as non-point sources. Tributaries and other inputs to Mission Creek exceeded FC standards and added FC loads. These include a pipe discharge just below the Tripp Canyon road crossing of Mission Creek, the ditch from the Icicle Creek Irrigation District spill return, Yaksum Creek, and two culverts at the Pioneer Street bridge crossing. One of the culverts diverts spill-water from the Peshastin Irrigation District to Mission Creek; however, the Peshastin Irrigation District also spills water to Brender Creek (at station PS00.1) and did not

have FC exceedances there. This suggests there are other non-point contributions to the water within the culvert, which is also part of the City of Cashmere stormwater collection system.

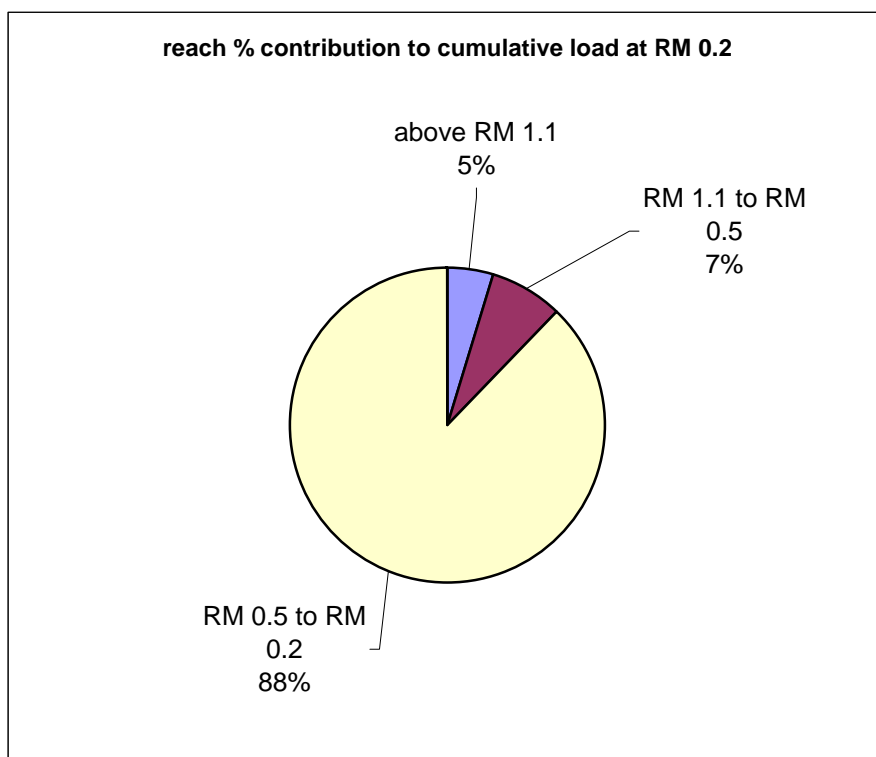
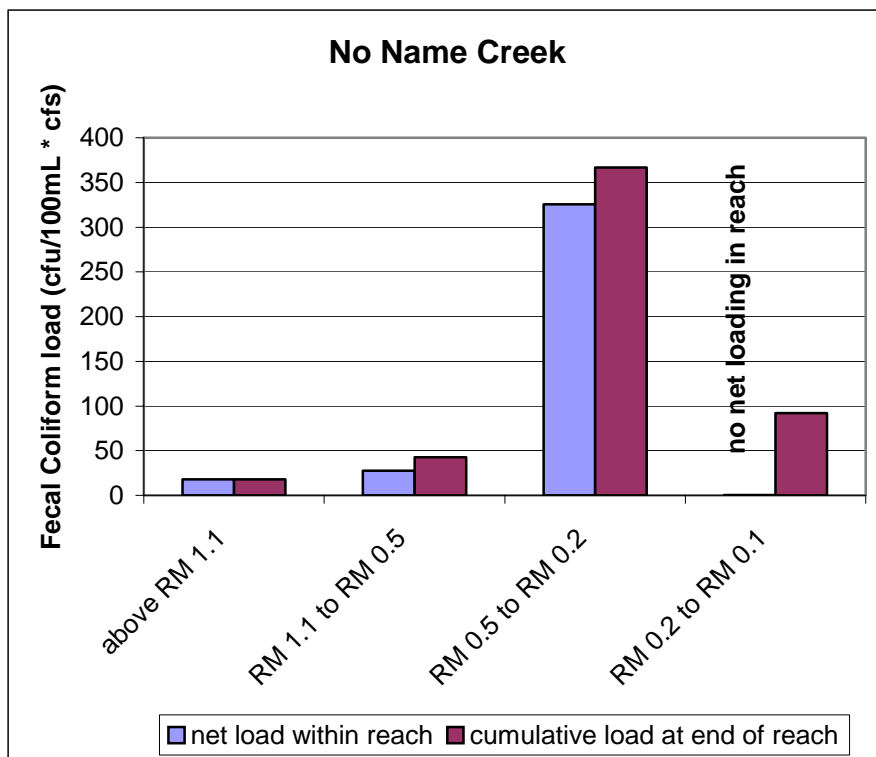


Figure 15. Net and cumulative FC loads in No Name Creek with reach % contribution (for the period of July through October 2003; n=9).



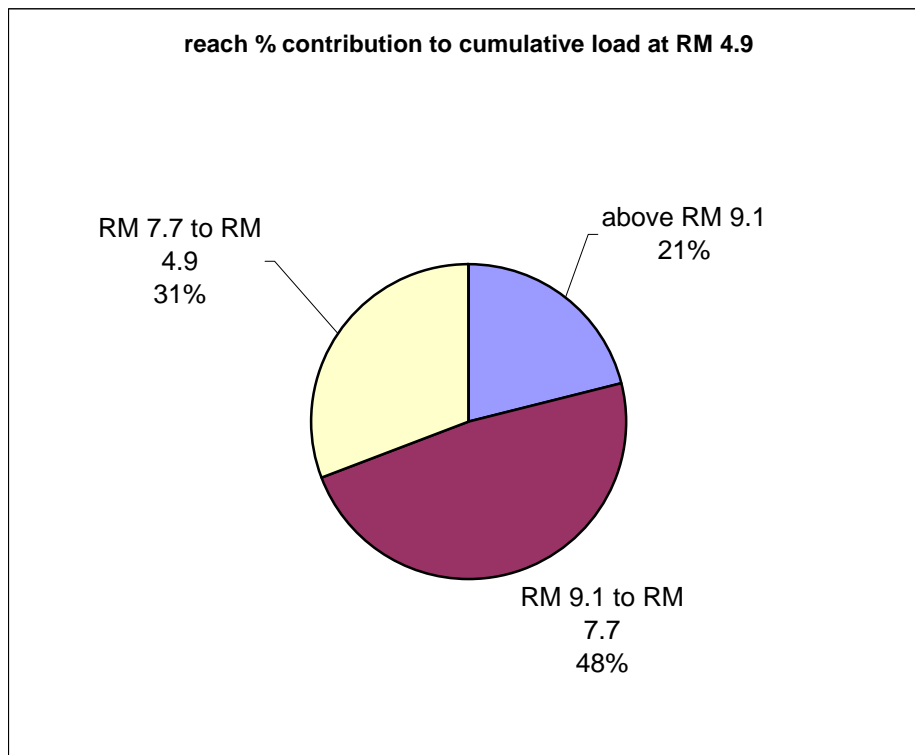
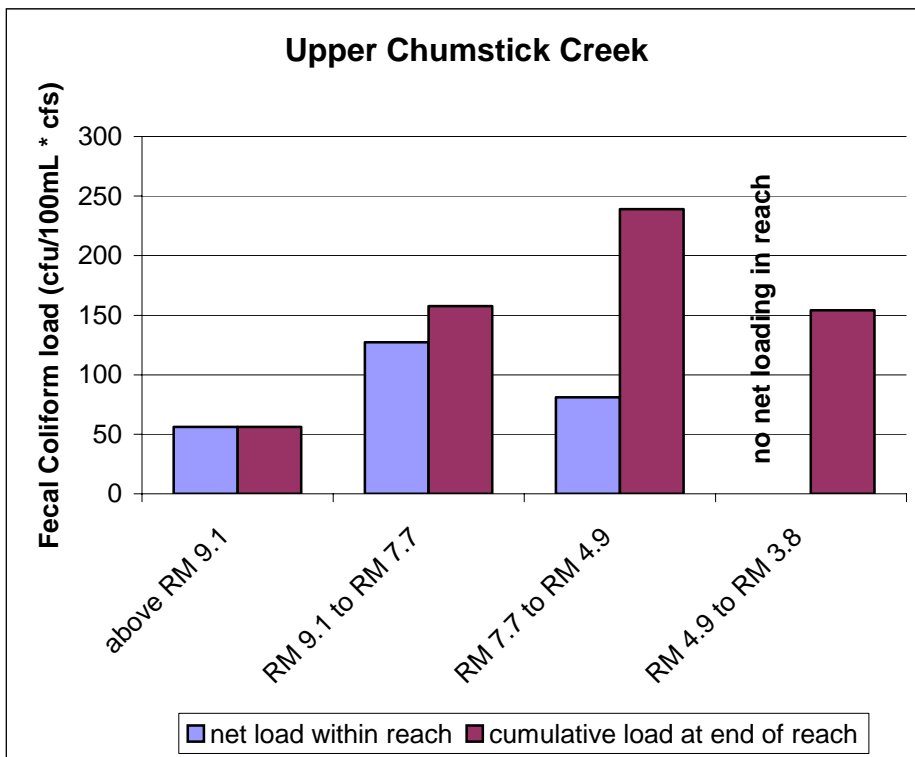


Figure 16. Net and cumulative FC loads in upper Chumstick Creek with reach % contribution (for the period of July through October 2003; n=10).

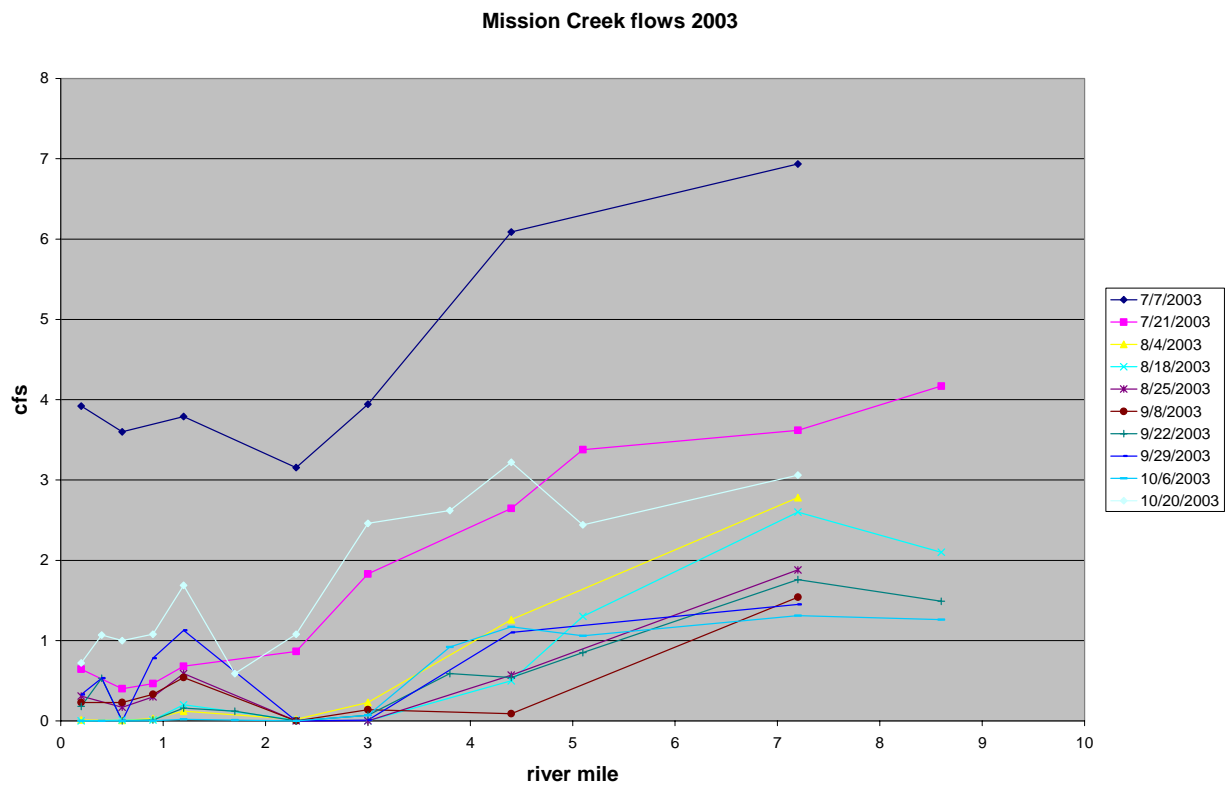


Figure 17. Mission Creek flows during the 2003 sampling surveys.

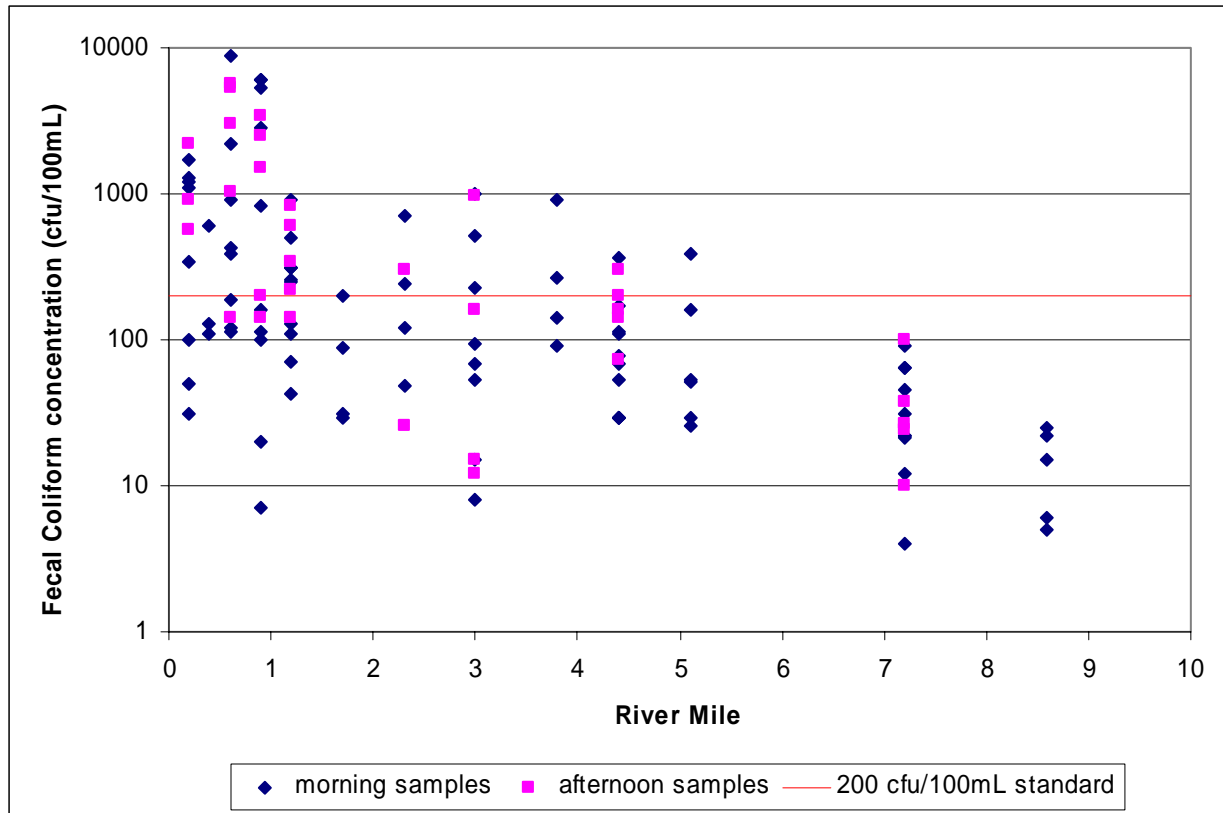


Figure 18. Fecal coliform bacteria concentrations in Mission Creek during the July through October 2003 sample surveys.

In addition to FC exceedances, Table 24 presents the pH and DO exceedances during the Year 2 data collection. Implementing control measures for FC will likely mitigate other water quality concerns in the Mission, Brender, and Chumstick basins, such as high nutrient levels, high pH, and low DO.

This interim report concludes before the second round of Year 2 (2004) bacteria sampling. All of the tributary watersheds will be sampled for FC beginning in February/March 2004 during spring run-off and storm events to provide a wet season assessment. The water quality of Mission, Brender, and Chumstick watersheds will be discussed in more detail in the final project report in 2005.

Table 24. Instantaneous (grab sample) pH and DO exceedances from **Year 2** sampling in Mission, Brender, and Chumstick basins.

Station	Date	pH		Station	Date	DO (mg/L)	
45EG05.8	8/20/2003	8.7		45BR00.4	7/22/2003	6.0	
45EG05.8	8/27/2003	8.6		45BR00.4	8/5/2003	6.2	
45MC00.2	5/5/2003	8.6	J	45BR00.4	8/5/2003	6.7	
45MC00.6	8/4/2003	8.6		45BR00.4	8/19/2003	6.7	
45MC00.6	8/18/2003	8.6		45BR00.4	8/26/2003	7.2	
45MC01.7	9/22/2003	8.7		45BR00.4	10/7/2003	7.0	
45MC01.7	10/6/2003	8.6		45BR00.4	10/20/2003	6.5	
45MC02.3	7/7/2003	8.6		45BR00.5	10/7/2003	7.0	
45MC02.3	7/21/2003	8.7		45BR00.5	10/20/2003	6.0	
45MC03.0	7/21/2003	8.7		45BR01.4	10/20/2003	7.9	
45MC03.0	8/4/2003	9.1		45CS01.0	9/24/2003	5.4	J
45MC03.0	8/4/2003	8.7		45CS01.0	10/1/2003	6.5	
45NN01.1	8/19/2003	8.9		45EG00.9	8/20/2003	6.9	
45NN01.3	7/22/2003	8.6		45EG00.9	9/10/2003	7.5	
45NN01.3	8/5/2003	8.7		45ID00.1	7/22/2003	7.9	
45PR00.1A	8/19/2003	8.6		45ID00.1	8/5/2003	5.9	J
45PS00.1	7/8/2003	8.6		45ID00.1	8/19/2003	7.2	
45PS00.1	8/26/2003	8.7		45ID00.1	9/9/2003	6.2	
45PS00.1	9/30/2003	8.6		45ID00.1	9/23/2003	7.5	J
45SN00.1	8/18/2003	8.6		45MC00.6	8/18/2003	6.7	
45VC00.1	7/9/2003	8.6		45MC00.6P	10/20/2003	7.0	
45VC00.1	8/20/2003	8.7		45MC00.9	8/4/2003	7.9	
45VC00.1	8/27/2003	8.6		45MC00.9	8/18/2003	4.8	
45VC00.1	8/27/2003	8.6		45MC00.9	9/22/2003	7.0	
45WR00.5	9/8/2003	9		45MC00.9	10/6/2003	4.3	J
				45MC02.3	8/4/2003	4.6	
				45MC02.3	8/4/2003	6.4	
				45MC02.3	8/18/2003	4.9	
				45MC03.0P	8/18/2003	7.3	
				45NN00.2	10/7/2003	7.1	
				45NN00.3	10/7/2003	7.0	
				45PRM00.1	10/20/2003	7.7	
				45PS00.1	8/5/2003	7.9	

## Conclusions

Overall, the data collected by Ecology for this project met the data quality objectives. There was high variability in the Year 2 data; however, the QA and QC review suggests that the Ecology data are of good quality and are properly qualified.

In Class AA reaches, natural DO concentrations will likely reach less than 9.5 mg/L during the summer months due to high water temperature. Implementation of the Wenatchee National Forest temperature TMDL and the upcoming Wenatchee River temperature TMDL will improve temperature (and therefore DO) as much as possible; however, in addition, current and future BOD and nutrient loading should be restricted in the Class AA waters to keep from further reducing DO concentrations in these reaches.

The diurnal and some grab sample data showed that the DO criterion of 8 mg/L and the upper pH criterion of 8.5 pH units were exceeded in Class A reaches of Icicle Creek (at the mouth) and in the lower Wenatchee River from RM 21.0 (above Peshastin) to the mouth. Particularly, a deleterious low-DO condition seems to exist at the mouth of the Wenatchee River, perhaps in relation to the back-up of Columbia River water into the mouth channel of the Wenatchee River. The mouth of the Wenatchee River appears to be the most water-quality limited segment in the Wenatchee basin.

Based on nitrogen to phosphorus ratios (N:P ratios) of bio-available nutrients in the Wenatchee River, phosphorus appears to be the nutrient to control periphyton biomass in the lower reaches of the Wenatchee River.

The FC criterion was exceeded throughout the Mission, Brender, and Chumstick creek watersheds except at or near each respective Forest Service headwater boundary. Simple mass-balance load analyses of the each creek identified specific reaches with the highest FC loading to the creeks. Agriculture, on-site septic systems, and wildlife are potential non-point sources within these reaches. There were also DO and pH exceedances within these tributary watersheds, though controls measures for FC will likely mitigate these other water quality concerns.

The data that were quality-assured in this report – along with flow, water level, meteorological, and bathymetry data from other sources – will be used to build and calibrate a QUAL2K model of the Wenatchee River and lower Icicle Creek. Ecology will use the model to recommend TMDL pollutant limitations to protect the water quality of the Wenatchee River and Icicle Creek. In addition, FC data assessed in this report will be used to develop bacteria mass balances to identify tributary reaches with high bacteria loading and establish FC load allocations.

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# Appendix A

## Wenatchee TMDL Point Sources – Permit Limits and Background

### Leavenworth WWTP

Permit No. WA-002097-4 for the city of Leavenworth Publicly-Owned Treatment Works (POTW), was issued April 28, 2000, became effective June 1, 2000, and expires May 31, 2005. Discharge is to the Wenatchee River.

Effluent Limitations: Outfall # 001		
Parameter	Average Monthly	Average Weekly
BOD5	30 mg/L; 210 lbs/day 85% removal	45mg/L; 315 lbs/day
TSS	30 mg/L; 210 lbs/day 85% removal	45 mg/L; 315 lbs/day
Fecal Coliform Bacteria	200/100 mL	400/100 mL
pH	shall not be outside the range of 6.0 – 9.0	
Additional Effluent Limitations: Outfall # 001		
Parameter	Daily Maximum	
Total Ammonia (as NH3-N)	15.5 mg/L; 165 lbs/day	

The city of Leavenworth operates wastewater collection and treatment facilities serving residential and commercial customers within the city limits of Leavenworth. In recent years the treatment plant reached, and on occasion exceeded, its design capacity. In addition, the city determined that the treatment plant did not have the capability to meet receiving water standards for toxic constituents. In addition, the collection system was found to have several major deficiencies, with portions over 50 years old and reaching the end of their service life. Finally, a significant population growth for the city was projected over the next 20 years, suggesting a further demand on wastewater services.

In response the city prepared a *Wastewater Facilities Plan* in 1996. The plan recommended a comprehensive program of collection system rehabilitation and maintenance, including separation of storm sewers from the sanitary sewer system, and expansion and upgrade of the treatment plant, including an improved sludge management program, ultraviolet (UV) disinfection and enhanced treatment capacities. Improvements in the *Facilities Plan* were based on a 20 year planning horizon (1995 to 2015), when the service population is predicted to increase from 2020 to 4483.

Between 1971 and 1973 a major project was undertaken to separate storm water flows from the sanitary wastewater flow by constructing a separate storm sewer system. The *Facility Plan* has addressed deficiencies in the collection system and the city signed a contract to implement a TV inspection of the system to identify areas of needed repair or replacement.



The Leavenworth WWTP has been upgraded. Before the upgrade, the plant consisted of headworks, two oxidation ditch aeration basins, two secondary clarifiers, chlorination facilities, and discharge to the Wenatchee River. With the new WWTP, wastewater processing begins with an anoxic conditioning tank, or selector, to improve sludge settling characteristics. The wastewater is then processed by a new oxidation ditch aeration basin, followed by secondary clarification and UV disinfection before being discharged to the Wenatchee River.

The process for the current permit included a preliminary evaluation of the discharge's potential for exceedance of the water quality standards for ammonia. Based on this preliminary evaluation, the discharger does not have a reasonable potential for exceedance of the water quality standards for ammonia. Nitrification (oxidation of ammonia) is expected to occur in the normal course of biological treatment in the plant, especially in warmer seasons. The permit recommends that the plant operator implement necessary actions to maintain optimum plant nitrification during the critical period.

### **Peshastin WWTP**

Permit No. WA-005217-5 for Chelan County PUD No. 1, Community of Peshastin Publicly Owned Treatment Works (POTW), was issued May 11, 2000, became effective June 1, 2000, and expires on May 31, 2005. Discharge is to the Wenatchee River.

Effluent Limitations: Outfall # 001		
Parameter	Average Monthly	Average Weekly
BOD5	30 mg/L; 19.3 lbs/day 90% removal	45mg/L; 29.0 lbs/day
TSS	30 mg/L; 9.6 lbs/day 85% removal	45 mg/L; 14.4 lbs/day
Fecal Coliform Bacteria	200/100 mL	400/100 mL
pH	shall not be outside the range of 6.0 – 9.0	
Additional Effluent Limitations: Outfall # 001		
Parameter	Average Monthly	Daily Maximum
Total Ammonia (as NH3-N)	10 mg/L; 9.2 lbs/day	14 mg/L; 13.8 lbs/day

The Peshastin Wastewater Treatment Plant (WWTP) serves the unincorporated community of Peshastin and two fruit packing facilities near the plant. There have been plans to provide service to an additional industrial site being developed adjacent to the WWTP. In the past chemical additives used by the fruit packers have interfered with the treatment plant's ultraviolet disinfection process, causing exceedances of its fecal coliform effluent limits. The fruit packers decided to conduct an engineering study to correct their pretreatment problems.

Wastewater from residences receives preliminary treatment in a septic tank effluent pumped (STEP) system. Preliminary treatment occurs onsite at each residence, since the septic tank acts as a primary clarifier. Most of the solids remain in the septic tank; therefore, smaller diameter

sewer lines are used and the main treatment plant does not require grit chambers, bar screens, or other unit processes typically associated with a headworks.

Flows entering the main treatment plant are first pretreated by caustic soda or prechlorination injection systems, if necessary. The caustic soda system is used to maintain effluent pH above 6.0. The treatment plant is designed to nitrify wastewater (oxidize ammonia). During the nitrification process, wastewater alkalinity is consumed. Once all or most of the alkalinity is consumed, nitrification is diminished and the wastewater is subject to rapid changes in pH. During operation of the caustic injection system, the operator must closely monitor ammonia levels and effluent pH. The purpose of the pre-chlorination system is to minimize toxicity and odors caused by hydrogen sulfide in the influent, a common occurrence with pressurized collection systems.

The treatment plant uses a continuous-flow batch reactor (SBR) system to provide secondary treatment. Two SBR systems react independently, with only one operated during seasons of lower influent flow. Each SBR follows a four-phase process that combines aeration and clarification in the same basin, thereby eliminating the need for separate clarifiers and return activated sludge pumps. Each SBR can also be converted for ammonia, phosphorus, or nitrogen removal by altering the aeration and settling sequences. After leaving the SBRs, the effluent passes in front of ultraviolet lamps for final disinfection. The plant has two sludge digesters. During normal operation the SBR system is completely automated, although the operator must monitor process control parameters to ensure the system processes are working effectively.

### Cashmere WWTP

Permit No. WA-002318-3 for City of Cashmere POTW was issued January 22, 2001, became effective March 1, 2001, and expires February 28, 2006. The final limitations, shown in the table below, begin on July 1, 2003, lasting through February 28, 2006. Discharge is to the Wenatchee River.

Effluent Limitations: Outfall # 001		
Parameter	Average Monthly	Average Weekly
BOD5	45 mg/L, 354 lbs/day and 65% minimum removal	65mg/L, 511 lbs/day
TSS	75 mg/L, 590 lbs/day	112 mg/L, 880 lbs/day
Fecal Coliform Bacteria	200/100 mL	400/100 mL
pH	shall not be outside the range of 6.0 – 9.0	
Additional Effluent Limitations: Outfall # 001		
Parameter	Average Monthly	Daily Maximum
Total Residual Chlorine	Minimized	0.05 mg/L, 0.4 lbs/day
Total Ammonia	to be determined	to be determined

The Cashmere WWTP provides wastewater collection and treatment for a combination of residential, commercial, and industrial contributors. Industrial users are Tree Top, Inc, a fruit

processing facility, two fruit packing facilities, and Liberty Orchards, makers of applets and cotlets candies.

The facility provides secondary treatment with a three-cell lagoon system, chlorine disinfection, and dechlorination. The city also operates a Bulk Volume Fermenter (BVF) for pretreatment of fruit processing wastes.

The city had intermittent compliance problems during the permit period beginning 1995 as a result of algal blooms in the lagoons. In the late autumn of 1999, the city installed baffles and a cover over the final lagoon, which, according to the current fact sheet, appears to have eliminated compliance problems related to algal blooms. The fact sheet states that the city has been adding hydrochloric acid to control pH and notes that suspended solids cannot be easily controlled, exceeding permit limits three to four months of the summer and early fall.

During the current 2002-2003 Wenatchee TMDL sampling events, some samples were noticeably green and the lagoons continue to produce a high pH effluent at times. City personnel continue to add acid to the effluent seasonally to bring pH to within permit limits.

The permit issued in 2001 requires compliance with the established effluent limits and self-monitoring to verify compliance; two Infiltration and Inflow Evaluations; two Wasteload Assessments; and a new Operation and Maintenance Manual.

In 1999 the city requested an amendment to its urban growth boundary. The annexation added approximately 96 acres to the west of the city, including the Chelan County Fairgrounds. The annexation resulted in a 30 percent increase in the population projections contained in the 1995 *Comprehensive Sewer Plan*. In November 1999 the Department received an amendment to the plan which describes measures the city took to accommodate the expanded wastewater service area. These measures include construction of the West Cashmere Lift Station and the addition of 4.5 miles of sewer pipe. The amendment to the plan was approved by the Department in November 1999. Expansion of the collection system was completed in September 2000.

A *Facility Plan* was written in response to an Administrative Order issued by the Department in 1995. The order noted that the city's treatment facilities had neared or exceeded NPDES permitted influent and discharge capacities on a number of occasions, and required the city to submit a plan to maintain adequate capacity.

The city's facility planning is being undertaken in two phases, Phases I and II, to cover a 20-year planning horizon. Planned improvements include replacement of the lift station, removal of stormwater discharges, installation of a cover over lagoon #3, installation of a dechlorination system, and implementation of a groundwater monitoring program. These had been accomplished at the time of permit issuance, with the groundwater monitoring program in development.

The *Facility Plan* does not offer specifics regarding Phase II, other than stating that the process will begin as the facility approaches 85% of design capacity. Phase II is said to involve a major upgrade concerning the capacity and leakage of the lagoons. Design criteria (200-2005) include

0.943 MGD combined maximum month flow rate, 11,200 lbs/day combined BOD to lagoon system (from both municipal and BVF).

The following BVF pretreatment wastewater characterization table, based on data from November 1997 through October 1998 is from the current fact sheet:

Parameter	Influent			Effluent		
	Annual Average	Lowest Monthly Average	Highest Monthly Average	Annual Average	Lowest Monthly Average	Highest Monthly Average
Flow (MGD)	0.245	0.045	0.332	NR	NR	NR
BOD <sub>5</sub> (lbs/d)	5,731	501	8,776	34.9	10	74
TSS (lbs/d)	2,519	166	3,649	333.1	19	992
pH range	NR			Low pH = 6.2    High pH = 8.1		

NR – Not Reported

During this 12 month period BOD removal rates for the BVF ranged from 98% to nearly 100%. TSS removal rates were not as consistent, ranging from 67% to 96%, but were generally 85% or better. Average BOD effluent concentrations ranged from 7 mg/L to 27 mg/L, with concentrations usually between 13 mg/L and 18 mg/L. TSS concentrations varied significantly, ranging from 51 mg/L to 432 mg/L, but most often running between 100 mg/L and 250 mg/L.

The current permit contains a Schedule of Compliance requiring the city to sample effluent ammonia concentrations and receiving water temperature and pH to provide the Department with sufficient data to conduct a reasonable potential analysis. In the event reasonable potential is determined, other than accepting permit limits for ammonia, the city has the option of doing an Effluent Mixing Study.

### **Chelan County Public Utility District #1 Town of Dryden WWTP**

Permit No. ST-5562 for Chelan County PUD #1 town of Dryden WWTP was issued August 3, 2000, became effective September 1, 2000, and expires August 31, 2005. The permit allows discharge to ground water via percolation. The permit stipulates the following numerical limitations:

Effluent Limitations: Outfall # 0001	
Parameter	Daily Maximum
Flow	0.023 MGD
Biochemical Oxygen Demand (5 day)	230 mg/L*
Total Suspended Solids	150 mg/L*
pH	Shall not be outside the range of 6.0 to 9.0

\* before discharge to the drainfields

The Chelan County Public Utility District #1 constructed the Town of Dryden Publicly Owned Treatment Works WWTP in the summer of 1981 as a septic tank/drainfield treatment system. The system was designed to serve 60 connections. No expansion or rehabilitation of major

facilities is currently scheduled. However, capacity of the plant will be required to be monitored as the connected population increases over the years.

The treatment facilities consist of two 23,000 gallon concrete septic tanks, a splitter box, three drainfield trenches comprising 1.37 acres, and two 841-gallon dosing tanks. The drainfield pipe is 4-inch diameter perforated, designed to distribute 1.1 gallons per square foot per day.

The permit fact sheet states that the wastewater receives anaerobic and then aerobic treatment, “which is considered an excellent way to disinfect wastewater prior to discharge back to groundwater near the Wenatchee River. Once the drainfield oxidants and reductants have been consumed by the river flora and fauna only the non-nutrient salts will remain in the waters of the Wenatchee River.”

Typically, only two drainfields are loaded at any time with the third left to rest, giving the plant a hydraulic design capacity of 23,000 gallons per day. The fact sheet states that “while resting, a drainfield breathes and fully oxidizes any ammonia that has been deposited in the soil.” The remaining two drainfields operate continuously during the resting period of one year. The fact sheet does not assess the potential for unoxidized ammonia to percolate into the river from the two active drainfields.

Discharge flow from the plant is determined by noting the count of tank drainages. Dave Johnston of the PUD indicated that flow distribution between the two active tanks has been erratic at times and the PUD has not been able to improve plant operation in this respect. He also pointed out a fruit packer about 200 feet uphill from the WWTP. The fruit packer was spray irrigating what may have been process water at the time of our September, 2002 visit.

The fact sheet states that the gravel and cobble-filled soils of the drainfield will be difficult to assess. Monitoring from two wells was required until Ecology determined the data was not of value in assessing the plant discharge (Dave Holland/ WQ/ CRO, personal communication, 2002). The current permit requires a Plan for Maintaining Adequate Capacity and an Infiltration and Inflow Evaluation, both to be submitted by March 1, 2003.

### **Lake Wenatchee POTW**

Permit No. WA-005209-4 for Lake Wenatchee WWTP was issued May 16, 2000, became effective July 1, 2000, and expires June 30, 2005. The permit allows discharge to the Wenatchee River from September 1 through April 30 of the following year, not to exceed eight consecutive months. The permit stipulates the following numerical limitations:

Effluent Limitations: Outfall # 0001		
Parameter	Average Monthly	Daily Limitation
BOD5	10 mg/L; 1.6 lbs/day	10 mg/L; 1.6 lbs/day
TSS	10 mg/L; 1.6 lbs/day	10 mg/L; 1.6 lbs/day
Fecal Coliform Bacteria	50/100 mL	230/100 mL
Dissolved Oxygen (DO) Min.	N/A	2.8 mg/L
Total Residual Chlorine	Minimized	0.5 mg/L; 0.08 lbs/d

Total NH3-N	7 mg/L; 1.1 lbs/day	10 mg/L; 1.6 lbs/day
pH	Shall not be outside the range of 6.3 to 8.7	

The permit stipulates that discharge to a sprayfield be limited only to that time period of April 1 through September 30 of each year, the period not exceeding 6 consecutive months. The permit stipulates the following numerical limitations:

Effluent Limitations: Sprayfield		
Parameter	Average Monthly	Average Weekly
Soluble BOD	20 mg/L; 8.3 lbs/day	30 mg/L; 12.5 lbs/day
TSS	45 mg/L; 18.8 lbs/day	67.5 mg/L; 28.1 lbs/day
Fecal Coliform Bacteria	N/A	240/100 mL
pH	shall not be outside the range 6.0 – 9.0	
Parameter	Average Monthly	Daily Minimum
Total Residual Chlorine	N/A	1.0 mg/L
Dissolved Oxygen Min.	N/A	0.2 mg/L
Parameter	Average Monthly	Seasonal Maximum
Total Kjeldahl Nitrogen	N/A	2,185 lbs
Total Flow	0.05 MGD	131 million gallons/season

Treated effluent is discharged to Class AA waters of the Wenatchee River during cold weather months. The facility collects and treats wastewater from private residences, a few commercial businesses, public and private campgrounds, and a U.S. Forest Service ranger station located around the eastern end of Lake Wenatchee.

The collection system is a STEP system; primary-level treatment of wastewater occurs in onsite septic tanks and is then conveyed to the main treatment plant through pressurized sewers. During warm weather months secondary level treatment occurs in a facultative lagoon and an adjacent 11.2 acre sprayfield. Wastewater receives tertiary-level treatment during cold weather months through use of a recirculating sand filter and polishing tank. Tertiary treated effluent is discharged to the Wenatchee River.

The Permittee's record of compliance was excellent for the permit cycle ending 2000. Influent design criteria of the treatment plant were exceeded in 1999 as the collection system was expanded to the state park. The inclusion of the state park took place without the addition of treatment capacity, as specified in 1997 engineering plans. Therefore the current permit requires submittal of a Plan to Maintain Adequate Capacity to the Department of Ecology.

# Appendix B

## Wenatchee TMDL, 2002-3 Sampling of WWTPs Summary of Field Notes and Influences of Sampling on BOD Results

Sampler: Steve Golding, Toxics Studies Unit, Water Quality Assessment Section, EAP

The following is a summary of three sampling events of wastewater plants for the Wenatchee TMDL. The sampling events were conducted July 22-25, August 26-29, and September 23-25. Dave Holland of the CRO assisted in July, Nigel Blakely assisted in August, and Kim Gridley assisted in August. The Leavenworth WWTP, Leavenworth Federal Fish Hatchery (Icicle Creek), Peshastin WWTP, and Cashmere WWTP were sampled on all three events. In addition, the Lake Wenatchee WWTP influent and effluent were grab-sampled in August as were the Dryden influent and effluent in September.

### Leavenworth WWTP

The Leavenworth WWTP discharges to the river throughout the year. The plant employs UV disinfection. The plant discharges to the river through a single port diffuser at the center of the river.

#### *July 22-25 '02 sampling event:*

A compositor was set up to take equal volumes of effluent every 30 minutes for 48 hours. A strainer was placed 3 feet upstream of the partial flume, after UV disinfection. No seed was added to the BOD sample and, in concept, the result may have been an artificially low BOD result since the microorganisms needed for a valid BOD test may have been killed by the UV. Lisa Reed of Leavenworth WWTP lab says that they also sample after UV and do not seed the BOD samples because they are concerned that with the plant's low BOD, seed would raise the BOD result artificially.

The Winkler sample was taken just downstream of a one foot fall, just upstream of the Parshall flume, in non-turbulent effluent.

#### *August 26-29 '02 sampling event:*

The compositor was moved to just before UV so that the sample would contain microorganisms for the BOD test. In this way, no seed was needed and none was added to the sample. The August result can be considered a valid BOD result for comparison with July's sample, collected and tested in the same way that the Leavenworth WWTP plant does. Consider TOC and TSS during sampling events as an indicator of true plant performance; they should correlate with BOD.

All Winkler and bacteria samples were taken after UV for all three sampling events.

As a result of a communications mixup, I used TOC filters for Ortho-P samples for all WWTPs, August sampling event only. A preliminary result of a later blank I submitted of blank water filtered with a TOC filter and analyzed for Ortho-P showed no contamination, so Ortho-P results for August may be ok.

Bill Russ, the plant operator reported to the Ecology central regional office a spill to the river that took place August 18, 2002. Upon arriving to work at 7:30 AM on August 18, the operator found that a check valve had failed and that a discharge of largely raw influent to the river had been taking place for about 3 hours. The estimated spill volume was 46,400 gallons, with an estimated 1,250 pounds of solids.

#### *September 23-25 '02 sampling event:*

The composite sample was collected upstream of UV and the BOD test was conducted without seed, as in August. A portion of the sample was of UV disinfected wastewater. When Bill told us he had changed his UV flow scheme since August we moved the compositor to collect most of its sample upstream of UV. Because UV has no residual, as does chlorine disinfection, and because most of sample was before UV, it can safely be assumed there were plenty of microorganisms for a valid BOD with no need of seed.

#### *April 7-9 '03 sampling event:*

A compositor was set up in the screening building to collect influent just upstream of screening. The strainer was in only about 4 inches of water so I let the strainer lie on the channel bottom; Flow was turbulent so the sample should be fairly representative. When the scum pump is operating, there is a recirculated stream added upstream of this sampling spot, but the operator reported that the scum pump would not be in operation while I was sampling. BOD testing of the influent sample was requested to be done without seed.

The effluent compositor was set up to sample before (upstream) of UV treatment. The intake was attached to a bamboo pole and placed about 2 feet below the surface. Coliform samples and D.O. samples were grabbed after UV treatment at the upstream end of the Parshall flume. Because the composite sample was taken before disinfection, effluent BOD testing was requested without seed.

#### **Plant Flows:**

8AM July 22 – 8AM July 23 2002: 321,566 gallons per day  
8AM Aug 27 – 8AM Aug 28 2002: 356,104 gallons per day  
8AM Sept 24 – 8AM Sept 25 2002: 339,864 gallons per day  
8AM April 7 – 8 AM April 8 2003: 281,570 gallons per day



## Peshastin WWTP

The Peshastin WWTP, rather than treating wastewater continuously, as do most wastewater treatment plants, treats wastewater in batches alternately in two tanks known as sequential batch reactors, or SBRs. Peshastin is a small town and much of the influent comes seasonal from two fruit processors during the packing season that begins in late summer. The SBRs are set to discharge at fixed time intervals (approximately every 2 hours) when flow does not exceed normal conditions. The SBR tanks are 24 feet in depth and the top 2 feet is decanted with each cycle. We set our compositors with this fixed time interval so that we would sample only during plant discharge periods. The plant was operating its sampler at shorter fixed intervals so that sample was being collected when there was no discharge and the effluent was stagnant and warm. I discussed with Dave Johnston, the plant operator, how this leads to invalid samples. I do not know whether or not this situation was remedied. The plant utilizes UV disinfection.

### *July '02 sampling event:*

The composite sample was collected downstream of UV and, although the microorganisms necessary for a valid BOD may have been killed by the UV, the BOD test was run without seed. As in the Leavenworth WWTP sample, the BOD result should be compared with the August and September sampling events (they were sampled in a valid way).

The plant was operating at half capacity, with only one of the SBR tanks and flow was relatively low since the fruit packers were not yet in the packing season (Dave said only Bluebird was contributing a small flow of about 2000-3000gpd. He reads their influent flow with a flow meter). The plant operated as expected with fixed timing cycles and our compositor collected samples during discharge periods as expected.

Because the municipal wastewater contribution to this plant is small and fruit packer wastewater is a major contributor and variable, the plant flow from day-to-day varies more for this plant than most.

### *August '02 sampling event:*

The compositor was placed before the UV so that the BOD sample would have plenty of microorganisms and not need to be seeded. Compare results with July, where sample was collected after UV and microorganisms may have been killed off.

All D.O. and bacteria samples were taken after UV for all three sampling events.

Plant flow was higher than expected so the plant was not running on a fixed time cycle and the compositor could not be used. Dave Johnston, plant operator, said that both Blue Bird and Hi Up (fruit packers) had just started seasonal contributions of wastewater that day. He had not expected Hi Up to be discharging yet. I have a copy of the plant's flow record for August, signed by Dave, that shows plant flow lower than 40,000 gallons per day from Aug 2-26. August 27, the time we were there, shows a jump in flow to 57,274 gallons. Dave was

preparing to begin using the plant's second SBR tank, but it would not be running during our inspection.

The plant had been operating in normal low-flow season operation during our July sampling. In September, it was operating in normal high-flow season operation. During this August sampling event it was in transition and operating at a higher load than normal. We took a grab sample of effluent during a discharge cycle at 1600 on August 26 to represent effluent during this relatively brief transition period of plant operation. The reason they don't run both sequential batch reactor (SBR) tanks year round is because the microorganisms ("bugs") wouldn't have enough food (organics) to maintain a healthy population.

#### *September '02 sampling event:*

The plant was operating with both SBR tanks in operation and the fruit processing plants were discharging to the city's sewer system to the Peshastin WWTP. The 49,000 gpd flow during the sampling period was typical of the packing season but lower than the 57,274 gpd flow of the August sampling period. Because the composite sample was collected beginning on a Monday, and operator Dave Johnston told us effluent is weaker early in week after fruit packers are closed on weekends, we collected a grab sample at 1330 on Sept 24 (Tuesday) as well.

#### *April '03 sampling event:*

The plant is still running with both SBRs as it does throughout the fruit processing season. Blue Bird is still doing some fruit packing and contributing some process water to the WWTP. The SBR cycle was 2 hr 25 min, with a cycle to begin 1:30 PM on April 8.

The influent is through a pressure line, so I used the facilities compositor for influent, placing our iced base in their open refrigerated sample enclosure. I set up an ISCO sampler to sample every 145 minutes during plant discharge periods, with the intake placed upstream of (before) UV.

#### Plant flows:

8AM July 23 – 8AM July 24 2002: 37,950 gallons per day  
8AM Aug 26 – 8AM Aug 27 2002: 57,274 gallons per day  
8AM Sept 23 – 8AM Sept 24 2002: 49,000 gallons per day  
8AM April 8 – 8 AM April 9 2002: 32,590 gallons per day

Self reporting shows the following flows for July-Oct '02:

Avg. (MGD)	Max.(MGD)	
July	0.035	0.057
August	0.036	0.059
September	0.045	0.058
October	0.051	0.064

## Cashmere WWTP

The Cashmere WWTP is a 3-lagoon system. The plant chlorinates and dechlorinates with SO<sub>2</sub>. The city samples before chlorination, since and can inflate BOD results. We set up the compositor at the outlet of the last lagoon, also before chlorination, for all three sampling events. It should be noted that the SO<sub>2</sub> added downstream of our sampling location exerts an additional oxygen demand not included in the sample. This also provides a sample with microorganisms that does not require seed. D.O. and bacteria samples were collected after chlorination and dechlorination for all three sampling events. The city dredged cell #1 the day before the July sampling. This would create a tendency toward lower quality effluent with more solids and associated organics, but Tom Hastings, operator, said he didn't think it would have any effect. The plant has a seasonal algae problem and high pH, so they add HCl to the effluent as needed. During the September sampling event Tom Hastings said they haven't added any acid since the end of July (they only do so when pH >9). We measured a pH of 8.09 during the September sampling event and Tom said they measure about 8.1.

### *April '03 sampling event:*

As in previous sampling events, the downstream half of the final pond was covered with black plastic to reduce algal growth and corresponding rises in pH. The pH is running about 8.5 according to operator Tom Hastings. He said they were not adding acid yet for the season as they will be later in the summer to bring down effluent pH as a result of algal pH increases. The water in the first pond looks green as it is sprayed by the aerator. The TOC effluent sample looks green as compared with the DOC clear sample.

The city samples influent as 2 separate flows separately from the city and the Treetop Bulk Volume Fermenter (BVF). Since this was impractical to do, I collected grab samples from the influent box where the 2 influents come in from separate pipes and mix.

The effluent compositor intake was submerged in the effluent box from the final pond, as in all previous sampling events. As before, D.O. and coliform samples were taken after disinfection, at the outfall of the chlorination basin, just upstream of a 1-foot drop into a vertical outflow pipe.

The plant operator, Tom Hastings, reports effluent BODs in the range of 20 to 30 mg/L.

### Flows:

7:30 AM July 24 – 7:30 AM July 25 2002: 0.3424 MGD  
7:30 AM Aug 26 – 7:30 AM Aug 27 2002: 0.3955 MGD  
7:30 AM Sept 23 – 7:30 AM Sept 24 2002: 0.300 MGD  
7:30 AM April 7 – 7:30 AM April 8 2003: 0.4420 MGD

## Leavenworth Federal Fish Hatchery (Icicle Creek)

### *Main discharge at Parshall flume to river:*

Two discharges were sampled at the fish hatchery. The main discharge to the river was sampled in the Parshall flume after the flows from the hatchery were commingled and well-mixed, just before the discharge reached the river. The second discharge was of the settling pond discharge, sometimes referred to by the sampler as “clean” discharge as the pond settled the cleaning water from tank cleaning. During all three sampling events the Parshall flume was flowing free so it could be used for valid measurements, and we measured the vertical distance from the water surface at the location in the flume where the ultrasonic detector used to be located (a PVC pipe is still there) as this is the location where flow is determined from Parshall flumes. This vertical distance was 205 cm at 1405 on July 23, 200 cm at 1110 on August 27, 208 cm at 1445. This lowest flow in August of the three sampling events corresponded with the concrete apron across the river just upstream of the discharge point being dry for the only time during the three sampling events. These vertical measured distances can be used to calculate flows if the Parshall flume width and vertical distance from the top of grate to bottom of flume are known.

The sampling point for the grab samples at the Parshall flume was at the upstream end of the flume in July and it is possible that the two nearby process water streams were not yet well mixed. This was remedied in the August and September sampling when the sampling point was moved to the downstream end of the flume, with considerable turbulence upstream of the sampling point for thorough mixing.

### *Settling pond (abatement pond) discharge:*

Dan Davies of the hatchery provided the following schedule for August tank cleaning. In general, some days involve more cleaning and a higher discharge than others. He says that no chlorine or any other disinfectant is used in the tank cleaning process.

#### August 2002

19, Monday	upper 8x80s and lower 10x100s
20, Tuesday	mid 8x80s
21, Wednesday	mid 8x80s and upper 10x100s
22, Thursday	lower 8x80s
23, Friday	upper 8x80s and lower 10x100s
24, Saturday	mid 8x80s
25, Sunday	upper 10x100s
26, Monday	lower 8x80s and lower 10x100s
27, Tuesday	upper 8x80s
28, Wednesday	mid 8x80s and upper 10x100s
29, Thursday	lower 8x80s

They leave a foot of water in the ponds so they only drain 3 feet of depth out of the 10x100s and 1.5 feet out of the 8x80s.

In July a grab sample from the settling pond was collected when we came upon it discharging at 1100 on July 22. Cleaning takes place in the morning and the Ecology flow meter showed that most of the pond discharge takes place in the morning.

We met Dustin Bilhimer at the cleaning pond on August 28 to read the datalogger for stage. It is my understanding that he reset the stage from 2.6' to 2.45' at 1045. From the data log we were able to see that there is a high discharge in morning when the tanks are cleaned, with flow tapering off rapidly thereafter. Based on this, we planned to sample the next day, making a flow-weighted grab composite by hand. On August 29, 2002, we grabbed samples every 15 minutes between 0615 and 0930, keeping each sample separate in the bottles of a sequential compositor. Then we flow weighted the samples based on the ISCO flow book charts for a 3.75 foot wide weir with end contractions. The maximum flow rate during that period was found to be approximately 6.9 cfs. The ambient section may have used a more precise formula to determine flow from the weir but our method was accurate enough for flow proportioning. The total flow volume during the sampling period was calculated to be approximately 17,700 cu ft. If the average base flow was about 0.3 cfs, an estimate, the unsampled 20.75 hr portion of that day's flow was approximately 22,400 cu ft, the estimated total flow per 24 hour period being 30,100 cu ft.

Because the August 29 sampling represented a lower than maximum volume of cleaning water, we sampled during a day when a maximum amount of cleaning water was discharged. This takes place on Mondays and Wednesdays and I sampled on the morning of Wednesday, September 25, 2002. The depth of flow over the weir was high, noticeably higher than during the August sampling. The maximum flow was estimated to be 7.8 cfs and the total discharge during the 8:00 AM – 10:00 AM sampling period was approximately 42,700 cu ft, more than double the volume sampled during the August sampling. If base flow is assumed again to be 0.3 cfs, the flow was 225,200 gallons per day.

*Summary estimated flows for Hatchery abatement pond:*

August 29, 2002: 30,100 cu ft (24 hour period)  
September 25, 2002: 66,460 cu ft (24 hour period)

More precise measurements of flows in the Hatchery abatement pond may be determined from the continuous flow recording devices Ecology placed in operation during the survey period.

## Dryden Treatment System

The small community of Dryden treats its wastewater in a community septic system. The system is operated by Dave Johnson, who also operates the Peshastin plant. Dave Johnson says that the groundwater problems in the area may be at least in part a result of the irrigation a few hundred feet uphill from a fruit packing house. Dave Holland of CRO says that there have been two sampling wells to monitor the effects of the system but that Ecology told the PUD not to sample any longer since the results were not helpful. The Dryden septic system consists of three drainfields, two being used any single year. The two chambers being used have an automatic switch to cause their use to be alternated. Dave told us he has had problems with uneven flow and irregular filling between the two tanks. Influent and effluent samples were collected from manholes on September 23, 2002

Flows: Discharge flow estimates are made by summing the number of tank fillings per period, knowing the volume of the tanks. Because the method is imprecise and flow is checked only once per week, it is appropriate to characterize flow by month. From self-reporting data, the following flows were estimated with measurement periods including portions of 2 months pro-rated:

January 2002:	73,500 gpd
February 2002:	71,300 gpd
March 2002:	98,600 gpd
April 2002:	78,200 gpd
May 2002:	77,800 gpd
June 2002:	83,600 gpd
July 2002:	58,200 gpd
August 2002:	65,600 gpd

## Lake Wenatchee WWTP

The Lake Wenatchee WWTP was sampled on August 26, 2002. Discharge to land is permitted from April 1 through September 30. During the winter a filter is used to improve effluent quality to tertiary standards for discharge to Class AA waters of the Wenatchee River. The plant was applying effluent to a sprayfield during the August 2002 sampling and less restrictive limitations applied than during the April 2003 sampling when discharge was to the River. We sampled from the influent and effluent vaults during the August 2002 sampling.

The WWTP was sampled again in April 2003 when a recirculating sand filter was being operated for tertiary treatment. I grab-sampled from a pressurized influent line and collected a 24-hour composite sample from the effluent box, just before effluent is released through a culvert to the river. (I did not sample before chlorination because there is a settling basin after the accessible non-chlorinated point). The effluent was chlorinated, the operator said to 0.03 mg/L, but not dechlorinated.

# Appendix C

## Results - Wenatchee TMDL Point Source Data

The following is a summary of results from data for the wastewater treatment systems sampled. Data include results from effluent sampled in July, August, and September 2002, as well as influent and effluent sampled in April 2003.

### QA/QC

Attached Excel tables show lab duplicate and field replicate results. Pairs of results and lab duplicates for all parameters have a relative percent difference (RPD) of less than 7%, except for chloride at 11% and fecal coliform at 58%. Field replicate results for all parameters had RPDs of less than 15%, except for TSS and DOC. TSS had values of 2 and 3 mg/L, showing good agreement despite the high RPD at these low values. DOC had a relative percent difference of 28%, indicating possible contamination of the field-filtered sample during filtering.

### Leavenworth WWTP

The plant performed very well throughout the survey. Effluent BOD<sub>5</sub> was nondetectable except for one value of 1.1 mg/L in April, 2003. The composite effluent sample had been collected before UV disinfection. This compares with a permit limit of 30 mg/L BOD<sub>5</sub>. The maximum effluent TSS during the survey was 4 mg/L compared to the permit limit of 30 mg/L. BOD<sub>5</sub> removal was found to be 99.5% during the April, 2003 sampling event, compared with a permit requirement of 85% removal. TSS removal was 98.9%, compared to a required 85%.

Effluent TOC values were close in value throughout the survey, another indication of uniform plant operation for the dates sampled.

Effluent NH<sub>3</sub> –N was less than 0.2 mg/L throughout the survey, compared to a permit limit of 15.5 mg/L. This indicates that near-complete nitrification was taking place, with a removal efficiency of 100.0%. NO<sub>2</sub>-NO<sub>3</sub> values were correspondingly elevated to above 7 mg/L throughout the survey, as ammonia was converted to nitrites and then nitrates. Alkalinity was substantially used in the nitrification process in August 2002 sampling event and, although it was not a factor during the survey, there is the potential for alkalinity to become limiting to nitrification, and the meeting of ammonia permit limits.

Fecal coliform counts were well within permit limits for the dates sampled.

Field measurements of pH showed all values within the permit limit of 6.0 – 9.0.

In July we sampled after UV disinfection and did not add seed for the BOD test. This is the protocol the WWTP uses for its monitoring. It is possible that this can cause an artificially low BOD result since UV can kill the microorganisms that are necessary for biochemical oxidation in the BOD test. In July and August we sampled upstream of UV and added no seed. The WWTP



continued to sample downstream of UV and add no seed. The following analysis is to test the hypothesis that sampling downstream of UV without adding seed suppresses the biochemical reactions in the BOD test, causing an under-reporting of BOD during the first (July) sampling event.

	BOD <sub>5</sub>	TSS	TOC (all mg/L, all composite samples)
July	2U	3	4.7
Aug	2U	4	5.8
Sept	2U	2	4.9

With the effluent of similar quality with respect to TSS and TOC (an indicator of organic content), the BOD<sub>5</sub> tests showed the same nondetect result. The effect of sampling downstream of UV and not adding seed when BOD is within the detectable range is not known. The possibility should be considered that during periods of less effective plant operation than were observed during this survey, the plant under reports effluent BOD.

### **Peshastin WWTP**

The plant performed well during the survey. Because of the variable nature of the fruit processing influent and the small size of the plant, the operator had to make adjustments, but effluent quality remained good.

Effluent BOD<sub>5</sub> was 4 mg/L and 6 mg/L (est.) compared to a permit limit of 30 mg/L. BOD<sub>5</sub> removal was determined in April, 2003 and found to be 98.8%, compared to a permit limit of 90%. Effluent TSS ranged from not detectable at a detection limit of 1 mg/L to 4 mg/L. TSS removal was calculated at 84.2% in April, 2003, slightly under the permit requirement of 85%. This was a result of the unusually low influent TSS concentration of 19 mg/L, presumably due to the nature of fruit industry process water.

Nitrification was near-complete during the survey, with effluent NH<sub>3</sub> concentrations consistently below 0.2 mg/L, meeting permit limits of 10 mg/L. NO<sub>2</sub>-NO<sub>3</sub> concentrations were correspondingly high, above 12 mg/L except for values below 3 mg/L in July, 2002. Ammonia removal was 100.0% in April. Alkalinity was not close to limiting nitrification.

Fecal coliform permit limits were met, with most values below detection limits.

All effluent pH values determined in the field were within permit limits.

### **Cashmere WWTP**

The plant performed well during the survey. Effluent BOD<sub>5</sub> ranged from 16 – 22 mg/L during the survey, compared to a permit limit of 45 mg/L. BOD<sub>5</sub> removal efficiency calculated from April, 2003 data was 82.2%, meeting the permit limit of 65%. Effluent TSS values ranged from 6 – 20 mg/L, meeting the permit limit of 75 mg/L. TSS removal efficiency was calculated at 84.4% in April, 2003.



Nitrification (oxidation of ammonia) was largely incomplete. Effluent  $\text{NH}_3$  concentrations ranged from 1.42 – 8.38 mg/L.  $\text{NO}_2\text{-NO}_3$  effluent concentrations were all below 0.8 mg/L except for one anomalous value of 4.95 mg/L. The finding in April, 2003 of effluent ammonia concentrations of approximately 8 mg/L compared to an influent concentration of 12.4 mg/L, as well as the relatively high  $\text{NH}_3$  concentrations throughout the survey suggest that low  $\text{NO}_2\text{-NO}_3$  effluent concentrations cannot be explained to be a result of denitrification in anoxic conditions, as might be suspected. Substantial alkalinity was present to provide for potential denitrification. This is further supported by alkalinity declining only slightly between influent and effluent in April. As the plant was functioning, with little nitrification occurring, effluent  $\text{NH}_3$  concentrations provide an oxygen demand for the receiving water.

Effluent fecal coliform counts ranged from 14 – 170 (est.)/100 mL, meeting the permit limit of 200/100mL monthly and 400/100mL weekly.

Field measurements of effluent pH were within limits during the survey.

### **Lake Wenatchee POTW**

The plant performed well during the survey. Effluent  $\text{BOD}_5$  was found to be 5 and 1.3 mg/L during the survey, compared to seasonal permit limits of 10 mg/L total  $\text{BOD}_5$  and 20 mg/L soluble  $\text{BOD}_5$ , respectively.  $\text{BOD}_5$  removal efficiency calculated from April, 2003 data was 98.8%.  $\text{BOD}_5$  removal was also efficient during the spray field discharge season in August, 2002. Effluent TSS values were 50 in August, compared to a permit limit of 67.5 mg/L average weekly for the spray field season. The effluent TSS value in April was 1 mg/L, compared to a permit limit of 10 mg/L daily. TSS removal efficiency was calculated at 90.0% in April, 2003. Effluent TSS was higher in August than was influent TSS.

Nitrification was essentially complete both in August and April, with  $\text{NO}_2\text{-NO}_3$  concentrations of 27.5 (est.) and 22.2 mg/L and  $\text{NH}_3$  concentrations of 0.128 and 0.122 mg/L for those two months, respectively. These ammonia concentrations are well below the permit limit for discharge to the river of 7 mg/L average monthly. Ammonia removal efficiency in April was 99.5 %. Sufficient alkalinity remained in the effluent so as not to constrain nitrification, with effluent alkalinity dipping to 31 mg/L (est.) only in August, a level that suggests alkalinity be watched by the plant operator.

The fecal coliform count met permit limits as did the pH measured in the field.

Plant flow in August, during the sprayfield season, was reported to be 0.0388 MGD. This is within the average monthly permitted flow of 0.05 MGD for that season.

### **Dryden WWTP**

The Dryden plant is a septic tank system. Influent and effluent can be sampled only from large concrete tanks with quiescent, sluggish flow, placing doubt on the representativeness of the samples. The actual effluent leaving the drainfields near the river could not be measured.

BOD<sub>5</sub> discharged to the drainfields was found to be 118 mg/L for a single measurement in September, 2002, meeting the permit limit of 230 mg/L daily maximum. TSS was 23 mg/L, meeting the permit limit of 150 mg/L. pH was within permit limits.

Self-reported flow data for the period of the survey indicate that the permitted daily maximum flow limit of 0.023 MGD was not exceeded. (Flow is recorded only weekly but represent flows less than the limit).

Ammonia discharged to the drainfield had a concentration of 25.8 mg/L.

### **Federal Fish Hatchery at Icicle Creek – Main Outfall**

As shown in the data table, BOD<sub>5</sub> and TSS concentrations in the fish hatchery main outfall discharge were below detection limits of 2 mg/L and 1 mg/L respectively. An exception was a TSS concentration of 2 mg/L from a grab sample collected on June 25, 2002. Effluent NH<sub>3</sub> concentrations ranged from 0.026 mg/L to 0.095 mg/L. While both NH<sub>3</sub> and NO<sub>2</sub>-NO<sub>3</sub> were found in low concentrations relative to those of the municipal wastewater treatment plants (WWTPs) in the survey, the finding of NH<sub>3</sub> and NO<sub>2</sub>-NO<sub>3</sub> in approximately equal concentrations indicates only partial or no nitrification of ammonia to nitrate was taking place in the facility. Because inflow to the hatchery was not sampled, data indicating changes in nutrients and alkalinity across the hatchery are not available to provide confirmation of this. Effluent alkalinity was more than adequate to allow for complete nitrification of the ammonia concentrations found in the effluent. The finding of only partial nitrification is not surprising since treatment is not provided for flow-through water.

### **Federal Fish Hatchery at Icicle Creek – Abatement Pond Effluent**

The abatement pond settles solids from daily cleaning of fish-holding tanks. The flow from the abatement pond spikes during the few hours after cleaning during weekday mornings. BOD<sub>5</sub> concentrations were not detectable throughout the survey at a detection limit of 2 mg/L. An indication of organic concentration is TOC and DOC, ranging from 1.1 – 1.6 mg/L throughout the survey. DOC tended to be approximately 0.1 mg/L lower than TOC, indicating that the organics in the effluent were substantially in dissolved form.

TSS ranged from 2 – 6 mg/L during the survey. NO<sub>2</sub>-NO<sub>3</sub> as nitrogen ranged from nondetect at 0.01 mg/L to 0.139 mg/L. NH<sub>3</sub> as nitrogen ranged from 0.05 – 0.071 mg/L. For most sampling dates, NH<sub>3</sub> concentrations were higher than NO<sub>2</sub>-NO<sub>3</sub>, indicating little or no nitrification of the pond effluent was taking place. Alkalinity was not limiting to nitrification. Phosphorus results were erratic in June and July, 2002, with two points higher than 49 mg/L. Other phosphorus results for the abatement pond discharge during the survey were 0.103 mg/L or lower.

Peshastin WWTP

The Peshastin WWTP, like the Leavenworth WWTP, was sampled downstream of UV in July and upstream in August and September, all three tests being run without seed:

BOD <sub>5</sub>	TSS	TOC	(all mg/L, composite samples)
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July	4	1U	7.0
Aug	?	4*	8.7*
Sept	6J	4	12.7

The results show that when the effluent was disinfected with UV and the BOD test was conducted without seed in July, a biochemical reaction took place yielding a BOD (4 mg/L). The September test results were in line with the July results. (Believe we took a grab BOD in August but have not been able to find the data). The somewhat higher BOD<sub>5</sub> result September is consistent with the somewhat stronger effluent as indicated by TSS and TOC. Although there are insufficient data for definite conclusions, it appears that sampling downstream of UV (as in August) provides enough live microorganisms in the sample for valid results without seeding. Any future sampling for the TMDL should continue to be upstream of UV disinfection, to ensure the validity of results, however.

## Peshastin WWTP Data, 2002-3

Type of sample: Date:	Effluent grab 7/23/02	Effluent comp 7/24/02	Effluent grab 8/26/02	Effluent grab 9/23/02	Effluent comp 9/24/02	Effluent grab 4/7-8/03	Effluent comp 4/7-8/03	Influent comp 4/7-8/03	% Removal Efficiency
BOD5 (mg/L)		4			6 J 6 J		1.6	135	98.8
BODU (mg/L)									
TSS (mg/L)	1 U	1 U 1 U	4 4	2 3	4 5	1 3	3	19	84.2
TDS (mg/L)	399	394 394	580 632	1030 846	1030	466 466	470	430	-9.3
TNVSS (mg/L)	1 U	1 U 1 U							
TOC (mg/L)	7.5	7.9 7.5	8.5 9	11.6 11.5	12.7 11.9	11.6 10.9	9.1	65.4	86.1
DOC (mg/L)	7.6	8 7.1	7.9 8.6	11 10.1	11.4	9.4 10	8.9	45.8	80.6
TPN (mg/L)	3.17	2.96 3.61	19.9 18.6	15.9 17.3	14.9	13.7 16.4	18.2	33.3	45.3
Phosphorus (mg/L)	3.69	3.5 3.53	7.19 6.84	7.99 J 7.77 J	7.97	7.41 6.92	7.05	5.3	-33.0
Ortho-P (mg/L)	4.52	3.3 3.83	7.47 7	7.34	7.44 7.14	7.66 6.94	7.06	5.3	-33.2
NO2-NO3 (mg/L)	2.15	2.07 2.82	19.8 J 17.8 J	16.1 1.72	15.1	12.8 14.8	16	0.033	-48384.8
NH3 (mg/L)	0.226	0.171 0.067	0.038 0.522	0.01	0.016 0.019	0.016 0.015	0.015	31.6	100.0
Chloride (mg/L)	37.9	37	45.2 41.1	68.5 J 56.9 J	68.5 J	57.9 53.7	54.6	41.7	-30.9
Alkalinity (mg/L)	217 214	218	168 175	186 182	190	179 174	170	351	51.6
E.Coli (#/100mL)		1 U	1 U	1 UJ		3 U 3 U 1 U 1 U			
Fecal Coli (#/100mL)		1 U	1 U	3 J		3 U 3 U 1 U 1 U			

\* - The September 23, 2001 NO2-NO3 value of 1.72 mg/L is an apparent outlier.  
- apparent outlier

### Leavenworth WWTP Data, 2002-3

Type of sample: Date:	Effluent grab 7/22/02	Effluent comp 7/23/02	Effluent grab 8/27-28/02	Effluent comp 8/28/02	Effluent grab 9/24-25/02	Effluent comp 9/25/02	Effluent grab 4/7/03	Effluent comp 4/7-8/03	Influent comp 4/7-8/03	% Removal Efficiency
BOD5 (mg/L)		2 U		2 U		2 U		1.1	219	99.5
BODU ) (mg/L)										
TSS (mg/L)	4 3	3	3	4 3	1 U	2 2	6 1 U	2	174	98.9
TDS (mg/L)	206 201	200	224	216 212	184	186 186	189 192	192	224	14.3
TNVSS (mg/L)	NAF NAF	1 U								
TOC (mg/L)	4.3 4.5	4.7	5.8	5.8 5.1	4.7 5.1	4.9	5.6 4.6 4.8	5.2	84.2	93.8
DOC (mg/L)	4.7 4.5	5.4	5.7	5.4 5.2	4.3	4.3 4.5	4.8 4.7	4.7	63.2	92.6
TPN (mg/L)	12.6 12.1	12.1	15.7	16.8 17.6	10.9	10.9 11.3	9.9 9.94	10.5	28.6	63.3
Phosphorus (mg/L)	2.78 2.93	3.03	5.74	6.04 6.07	1.71	2.21 2.36	2.14 1.97	2.26	4.89	53.8
Ortho-P (mg/L)	3.41 J 3.21 J	3.62	5.63	6.02 6.03	1.55	1.71 1.98	2.17 2.1	2.41	3.7	34.9
NO2-NO3 (mg/L)	11.5 11.8	11.5	15.7 J	16.6 J 17.3 J	10.6 1.19	1.16	8.58 7.91	8.93	0.264	-3282.6
NH3 (mg/L)	0.051 0.031	0.048	0.086 0.055	0.074	0.045 0.034	0.036	0.015 0.011	0.012	25.6	100.0
Chloride (mg/L)	28.8 30.3	30.5	28.7 27.9	29	26.6 J 29.5	29	27.8 27.6	27.5	28.4	3.2
Alkalinity (mg/L)	25 26	26	10 J	9 6	34	33 32	45 44	45	158	71.5
E.Coli (#/100mL)	3		8		1		2 9 3 UJ			
Fecal Coli (#/100mL)	3		31 J		1		4 3 6 J			

\* - The NO2-NO3 values of 1.19 and 1.16 mg/L for 09/24-25/02 are apparent outliers.

### Lake Wenatchee WWTP Data, 2002-3

Type of sample: Date:	Effluent grab 8/26/02	Influent grab 8/26/02	Effluent grab 4/9/03	Effluent grab 4/9/03	Effluent comp 4/8-9/03	Influent grab 4/8-9/03	% Removal Efficiency
BOD5 (mg/L)	5	112			1.3	106	98.8
BODU (mg/L)							
TSS (mg/L)	50	14	1	1 U	1	10	90.0
TDS (mg/L)	472	344	327	331	326	245	-33.1
TNVSS (mg/L)							
TOC (mg/L)	15.8	64.9 J	4.6	4.7	5.7	42.3	86.5
DOC (mg/L)	13.6	38.1	3.9	3.9	3.8	34.4	89.0
TPN (mg/L)	29.1	69.7	23.5	24.8	26	29.1	10.7
Phosphorus (mg/L)	7.15	9	2.81	2.85	2.85	4.12	30.8
Ortho-P (mg/L)	6.53	8.77	2.93	2.9	2.93	4.16	29.6
NO2-NO3 (mg/L)	27.5 J	0.026 J	22.9	23.5	22.2	0.019	-116742.1
NH3 (mg/L)	0.128	69	0.1	0.091	0.122	24	99.5
Chloride (mg/L)	114	61.8	33.2	32.2	34.7	24.9	-39.4
Alkalinity (mg/L)	31J	366 J	75.6	75.2	70.9	206	65.6
E.Coli (#/100mL)	3U			14			
Fecal Coli (#/100mL)	3U			26			

(NOTE: low influent TSS may mean stagnant, nonrepresentative int sample)

Low int'l chloride may indicate int and eff are of different batch character, can't be compared for efficiencies or removal)

## Dryden WWTP Data, 2002-3

Type of sample:	Effluent	Influent	% Removal
Type of sample:	grab	grab	
Date:	9/23/02	9/23/02	Efficiency
BOD5 (mg/L)	118	709	83.4
BODU (mg/L)			
TSS (mg/L)	23	131	82.4
TDS (mg/L)	328	403	18.6
TNVSS (mg/L)			
TOC (mg/L)	57.8	106	45.5
DOC (mg/L)	33.6	65.5	48.7
TPN (mg/L)	31.1	38.6	19.4
Phosphorus (mg/L)	4.17 J	4.08 J	-2.2
Ortho-P (mg/L)	3.26	1.44	-126.4
NO2-NO3 (mg/L)	0.01	0.564	98.2
NH3 (mg/L)	25.8	11.1	-132.4
Chloride (mg/L)	24.1J	16.9	-47.9
Alkalinity (mg/L)	297	228	-30.3
E.Coli (#/100mL)	NC		
Fecal Coli (#/100mL)	NC		

<SHOWS NON-REPRESENTATIVE SAMPLE?

### Cashmere WWTP Data, 2002-3

Type of sample: Date:	Effluent grab 7/24/02	Effluent comp 7/25/02	Effluent grab 8/26/02	Effluent comp 8/27/02	Effluent grab 9/23/02	Effluent comp 9/24/02	Effluent comp 4/7-8/03	Influent grab 4/7-8/03	% Removal Efficiency
BOD5 (mg/L)		16		22		22 J	16.2	91	82.2
BODU (mg/L)									
TSS (mg/L)	20 16	20	15 6	6	12 14	11	14 17 15 16	90	84.4
TDS (mg/L)	682 694	685	770 770	737	742 741	742	632 626 622	613	-3.1
TNVSS (mg/L)	2 2	2							
TOC (mg/L)	13.3 12.8	13.8	12.4 13.5	13.3	17.5 16.8	17.3	16.1 16.4 16.6	43.4	62.9
DOC (mg/L)	12.4 12.6	12.3	12.0 11.9	12.3	15 15.6	15.9	15 11 10.8	32.4	53.7
TPN (mg/L)	3.9 3.93	4.03	3.97 3.98	4.13	3.98 3.98	3.89	9.87 11.3 11.5	13.7	28.0
Phosphorus (mg/L)	4.13 4.12	4.19	5.32 5.23	5.33	5.65 J 5.5 J	5.44	2.33 2.29 2.29	2.17	-7.4
Ortho-P (mg/L)	3.82 4	3.93	5.18 5.22	5.1	5.36 5.48	5.51	2.51 2.3 2.15	1.59	-57.9
NO2-NO3 (mg/L)	0.01 U 0.014	0.01 U	0.011 J 0.01 UJ	0.01 J	0.524 4.95	0.55	0.75 0.77 0.75	0.196	-284.2
NH3 (mg/L)	1.57 1.91	1.86	1.56 1.64	1.66	1.35 1.42	1.68	8.38 7.45 7.57	12.4	32.4
Chloride (mg/L)			71.1 70.9	71.9	69.5 J 69 J	68.6 J	46.8 46.5 46.6	42.9	-9.1
Alkalinity (mg/L)	521 515	516	586 J 587	591 J	559 558	560	527 530 521	544	3.1
E.Coli (#/100mL)	110		74		57 J		3		
Fecal Coli (#/100mL)	170 J		86 J		120 J		14		



### Leavenworth Fish Hatchery Abatement Pond Outfall Data, 2002-3

Type of sample: Date:	grab 6/25/02	grab 7/22/02	grab 7/23/02	grab-comp 8/29/02	grab-comp 9/25/02	grab 10/22/02	grab 4/8/03
BOD5 (mg/L)		2 U		2 U	2 U		
BODU (mg/L)							
TSS (mg/L)	2	4	2	2	2	3 3	6
Turbidity (NTU)	1.7		0.9			1 0.9	2.7
TDS (mg/L)	27	30	32	38	39		
TNVSS (mg/L)	2	NAF	1				
TOC (mg/L)	1.6	1.1	1.1	1.3	1.2	1.2	1.4
DOC (mg/L)		1.1		1.1	1 U	1.3	1.3
TPN (mg/L)	0.126	0.088	0.126	0.194	0.206	0.045 0.063	0.304
Phosphorus (mg/L)	49.7	0.042	53.7	0.103	0.073	0.029 0.029	
Ortho-P (mg/L)	0.028	0.017 J	0.027	0.0665	0.0424	0.013 0.012	0.0396
NO2-NO3 (mg/L)	0.01 U	0.01 U	0.01 U	0.029 J	0.082	0.016 0.016	0.139
NH3 (mg/L)	0.05	0.037	0.058	0.056	0.071	0.013 0.015	0.056
Chloride (mg/L)	0.22		0.21	0.46	0.67 J	0.62 0.62	1.99
Chlorophyll (ug/L)							5.8
Alkalinity (mg/L)	13	16	16	25	29	34 33	40
E.Coli (#/100mL)						1 UJ 1 UJ	1 U
Fecal Coli (#/100mL)						1 UJ 2 J	1 U

## Leavenworth Fish Hatchery Main Outfall Data, 2002-3

Type of Sample: Date:	grab 6/25/02	comp 7/22-23/02	grab 8/27/02	grab 8/28/02	grab 9/24/02	grab 9/25/02	grab 10/22/02	grab 4/8/03
BOD5 (mg/L)		2 U				2 U		
BODU (mg/L)								
TSS (mg/L)	2	1 U 1 U 1 U	1	1 U	1 U	1 U	1 U	1 U 1 U
Turbidity (NTU)	1.1						0.5 U	0.5 U 0.5 U
TDS (mg/L)	28	27 28 26	30	36	50	51		
TNVSS (mg/L)	1	1 U 1 U 1 U						
TOC (mg/L)	1.2	1.4 1.1 1 U	1	1 U	1.1	1 U		1.2 1.4
DOC (mg/L)		1 1.1 1.3	1.8	1	1 U	1.1		1.3 1.3
TPN (mg/L)	0.1	0.135 0.144 0.155	0.105	0.105	0.214	0.224	0.025 U	0.21 0.21
Phosphorus (mg/L)	0.01	0.013 0.011 0.011	0.015	0.006	0.024	0.016	0.0065	
Ortho-P (mg/L)	0.01	0.012 0.0089 0.0071	0.013	0.007	0.013	0.014	0.0069	0.01 0.01
NO2-NO3 (mg/L)	0.01 U	0.011 0.013 0.013	0.022 J	0.026 J	0.152	0.157	0.018	0.08 0.08
NH3 (mg/L)	0.04	0.091 0.072 0.095	0.039	0.058	0.041	0.051	0.026	0.06 0.06
Chloride (mg/L)	0.24	0.31 0.24 0.3	0.38	0.41	0.91 J	1.91	0.64	1.12 1.14
Chlorophyll (ug/L)								0.47 0.43
Alkalinity (mg/L)		16 16 17	24 J	24	34	35	34	30 31
E.Coli (#/100mL)		1	1		1 U			
Fecal Coliform (#/100mL)		1 U	2		1 U			

\* - September data points are apparent outliers. NO2-NO3 data for other facilities in September 2002 were also anomalous.

## 2002-2003 Wenatchee River TMDL Point Source Flow Rates

Facility	Period of Record	Influent or Effluent	Flow (MGD)	Flow (cfs)
LeavWWTP	7/22-23/02	Effluent	0.321566	0.49746
LeavWWTP	8/27-28/02	Effluent	0.356104	0.55089
LeavWWTP	9/24-25/02	Effluent	0.339864	0.52577
LeavWWTP	4/8-9/03	Effluent	0.28157	0.43559
PeshWWTP	7/23-24/02	Effluent	0.03795	0.05871
PeshWWTP	(7/22-23/02)	Effluent	0.04606	0.07125
PeshWWTP	(7/21-22/02)	Effluent	0.02907	0.04497
PeshWWTP	8/26-27/02	Effluent	0.057274	0.08860
PeshWWTP	9/23-24/02	Effluent	0.049	0.07580
PeshWWTP	4/8-9/02	Effluent	0.03259	0.05042

From Peshastin WWTP self-reporting data:				
Month	monthly avg (MGD)	monthly max		
Jul-02	0.035	0.057		
Aug-02	0.036	0.059		
Sep-02	0.045	0.058		
Oct-02	0.051	0.064		
first wk Apr-02	0.039	0.047	Flow (MGD)	Flow (cfs)

CashmrWWTP	7/24-25	Effluent	0.3424	0.52969
CashmrWWTP	8/26-27	Effluent	0.3955	0.61184
CashmrWWTP	9/23-24	Effluent	0.3	0.46410
CashmrWWTP	4/8-9	Effluent	0.442	0.68377
LkWnWWTP	8/26-27/02	Effluent	0.0388	0.06002
LkWnWWTP	4/8-9/02	Effluent	0.01296	0.02005

Dryden WWTP flows based on tank emptyings. No flows are available for the day of sampling. Monthly flows (note that permit is as daily maximum flow)

Dryden WWTP	Jan-02	Effluent	0.07348	0.113674
Dryden WWTP	Feb-02	Effluent	0.07125	0.110224
Dryden WWTP	Mar-02	Effluent	0.09858	0.152503
Dryden WWTP	Apr-02	Effluent	0.07823	0.121022
Dryden WWTP	May-02	Effluent	0.07782	0.120388
Dryden WWTP	Jun-02	Effluent	0.08357	0.129283
Dryden WWTP	Jul-02	Effluent	0.05818	0.090004
Dryden WWTP	Aug-02	Effluent	0.0656	0.101483

Fish hatchery main outfall: at measuring point of Parshall flume (white pvc pipe that used to house depth recorder)  
The flume was flowing freely. Vertical distance from grate to surface of water at white pipe:

Time	Date	Vert. dist (cm)
1405	7/23/2002	205
1110	8/27/2002	200
1445	8/27/2002	208

# Wenatchee TMDL Point Source Effluent QA/QC Data - Results and Lab Duplicate Results

WWTP Facility:	Leavenworth		Peshastin		Cashmere		Lake Wen.		Dryden		Main Outfall		Leav Htchy		Leav Htchy			
	Samp	dupe	RPD	Samp	Dupe	RPD	Samp	Dupe	RPD	Samp	Dupe	RPD	Samp	Dupe	RPD	Samp	Dupe	RPD
BOD5 (mg/L)				6 J	6 J	0.0	22	22	0	5	5	0	118	105	11.7	2 U	2 U	0
							16	16	0	5	5	0				2 U	2 U	0
							24	24	0									
BODU (mg/L)																		
TSS (mg/L)				5	5	0.0												
Turbidity (NTU)																		
TDS (mg/L)	184	184	0.0										30	28	6.9			
	212	215	1.4															
TN/VSS (mg/L)																		
TOC (mg/L)	5.1	5.3		11.6	11.9	2.6	17.3	17.1	1.16				1.4	1.4	0			
							13.3	13.1	1.52									
DOC (mg/L)							12.0	12.1	0.83									
							12.6	13.2	4.65									
TPN (mg/L)							3.98	4.14	3.94				0.105	0.099	5.9			
Phosphorus (mg/L)				7.19	7.05	2.0												
Ortho-P (mg/L)				7.47	7.19	3.8												
				3.3	3.38	2.7												
NO2-NO3 (mg/L)							0.014	0.015	6.9									

RPD - relative percent difference, the difference between two values divided by their mean expressed as a percentage.

## Wenatchee TMDL Point Source Effluent QA/QC Data - (cont'd)

VWTP Facility	Leavenworth		Peshastin		Oakhmare		Lake Wen.		Dyden		Main Outfall		Abat. Pond	
	Samp	dupe	RPD	Samp	Dupe	RPD	Samp	Dupe	RPD	Samp	Dupe	Samp	Dupe	RPD
NH3 (mg/L)				0.010 U	0.010 U	0								
				0.067	0.066	1.5								
Chloride (mg/L)											0.3	0.27	11	
Chlorophyll (ug/L)														
Alkalinity (mg/L)				168	168	0					17	16	25	25
E.Coli (#/100mL)				1 U	1 U	0								
Fecal Coliform (#/100mL)	1	2		1 U	1 U	0	120	J 68	J 58:1					

RPD - relative percent difference, the difference between two values divided by their mean expressed as a percentage.

## Wenatchee TMDL Point Source Effluent QA/QC Data - Comparison of Results and Field Replicates

WWTP Facility:	Leavenworth			Peshastin			Cashmere			Lake Wen.	Dryden	Leav Htchry		Leav Htchry	
Date:	4/7/03						4/7/03					Main Outfall		Abat. Pond	
Sample type:	samp	rep	RPD	samp	rep		samp	rep	RPD	samp	rep	samp	rep	samp	rep
BOD5 (mg/L)															
BODU (mg/L)															
TSS (mg/L)	2	3	40.0				14	16	13.3						
Turbidity (NTU)															
TDS (mg/L)	192	191	0.5				632	617	2.4						
TNVSS (mg/L)															
TOC (mg/L)	5.2	5.2	0.0				16.1	16.6	3.1						
DOC (mg/L)	4.7	4.9	4.2				15	11.3	28.1						
TPN (mg/L)	10.5	9.09	14.4				9.87	10.3	4.3						
Phosphorus (mg/L)	2.26	2.31	2.2				2.33	2.33	0.0						
Ortho-P (mg/L)	2.41	2.39	0.8				2.51	2.35	6.6						

RPD - relative percent difference, the difference between two values divided by their mean expressed as a percentage.

## Wenatchee TMDL Point Source Effluent QA/QC Data - (cont'd)

WWTP Facility:	Leavenworth			Peshastin			Cashmere			Lake Wen.	Dryden	Leav Htchry		Leav Htchry	
Date:	4/7/03						4/7/03					Main Outfall		Abat. Pond	
Sample type:	samp	rep	RPD	samp	rep		samp	rep	RPD	samp	rep	samp	rep	samp	rep
NO2-NO3 (mg/L)	8.93	8.61	3.6				0.753	0.759 0.755	0.8 0.3						
NH3 (mg/L)	0.012	0.011	8.7				8.38	7.56	10.3						
Chloride (mg/L)	27.5	27.1	1.5				46.8	47	0.4						
Chlorophyll (ug/L)															
Alkalinity (mg/L)	45	44	2.2				527	522	1.0						
E.Coli (#/100mL)															
Fecal Coliform (#/100mL)															